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Modeling the Health and Medical Care Spending of the Future Elderly

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Policymakers face the challenge of understanding and managing future Medicare spending. Under current projections, it will rise from 2.6 percent of gross domestic product today to 9.2 percent in 2050. Demographics will be a key factor: The first wave of baby boomers turns 65 in 2010. But what if some biomedical advance revolutionizes medical practice? What if a cure were found for one of the deadliest diseases? What if the health status of the elderly continues to improve? What if prevention efforts become more effective? Would such changes ease Medicare's financing problems?

To answer such questions, a team of economists and physicians from the RAND Corporation, Stanford University, and the VA [Veterans Affairs] Greater Los Angeles Healthcare System explored how changes in medical technology, disease, and disability would affect health care spending for the population age 65 and older. Their key findings: Medical innovations will result in better health and longer life, but they will likely increase, not decrease, Medicare spending. Eliminating any one disease will not save a great deal of money, but reducing obesity might be an important exception. Also, prevention efforts focused on the most important risk factors for disease, especially those requiring costly treatments, could be very cost-effective.

Key findings:

- **Medical innovations will improve health and extend life, but they will probably increase, not decrease, Medicare spending.**
- **Eliminating any one disease, with the possible exception of obesity, will not save Medicare money mainly because of valuable life extension.**
- **Better prevention could decrease costs and improve health, but the value of specific prevention efforts reflects both clinical outcomes and demographic trends.**

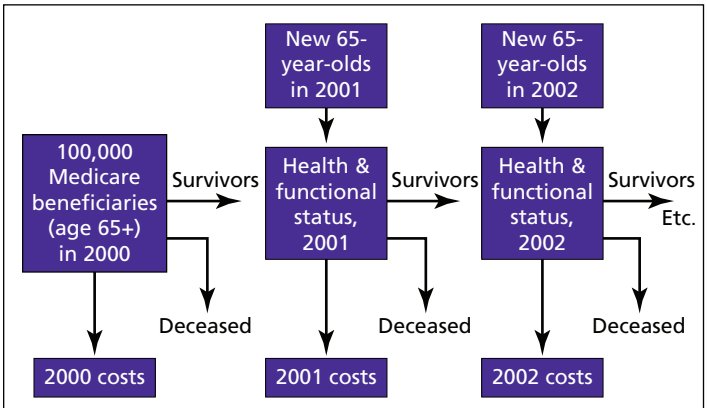
Modeling the Future

Economist Dana Goldman and his colleagues developed the Future Elderly Model (FEM), a demographic and economic model to predict future costs and health status for the elderly (see Figure 1). The model uses a representative sample of approximately 100,000 Medicare beneficiaries age 65 and over drawn from the Medicare Current Beneficiary Surveys, national surveys that ask Medicare beneficiaries about chronic conditions, use of health care services, medical care spending, and health insurance coverage. Each beneficiary in the sample is linked to Medicare claims records to track actual medical care use and costs over time.

The model begins with the health status of the sample in the current year; estimates the medical services they will use; and simulates the change in their health and functional outcomes, including death, over the course of the year. One of the important innovations of this model is its incorporation of information about the health of younger cohorts that will eventually age into Medicare. Specifically, a new set of 65-year-olds is added every year through 2030, and their health is also predicted based on the health of younger cohorts as described in the National Health Interview Study, another national survey. Rolling the model forward year after year makes it possible to predict medical costs and health status far into the future.

The research team used FEM to explore how future Medicare costs might be affected by health status trends, medical innovations, reduction of chronic diseases, and the number of elderly who are obese.

Figure 1
Approach to Modeling the Future Health and Spending of the Elderly



SOURCE: Goldman et al., 2005, Exhibit 1, used by permission.

Table 1
Health Care Spending Per Medicare Beneficiary Under Three Sets of Assumptions

	Health Care Spending Per Medicare Beneficiary (2005 dollars)		
	2000	**2015**	**2030**
Scenario A Uses information about the health of younger cohorts	$10,929	$11,000	$11,206
Scenario B Assumes new cohorts have the same health status as 1990 cohorts	$10,852	$10,725	$10,850
Scenario C Assumes continued improvement in the health status of the elderly	$10,852	$10,459	$10,275

Effects of Health Status on Medicare Spending

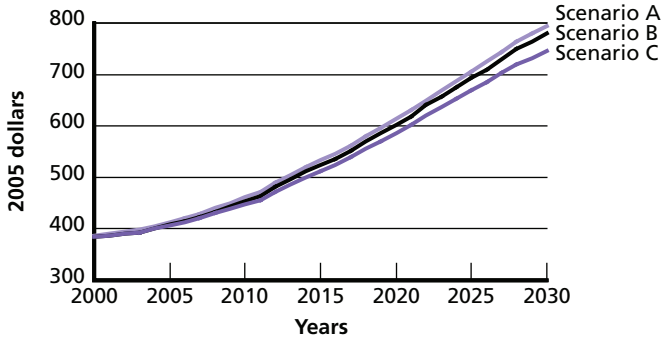
The health of the population over age 65 has been improving since the early 1980s. But recent increases in chronic disease, obesity, and disability suggest that future Medicare beneficiaries might be less healthy than current ones. To understand the net effect of these trends on Medicare spending, the research team used the model to estimate the health of future Medicare beneficiaries under three sets of assumptions.

- In scenario A, the research team forecast the health of new beneficiaries using all the information available, including the health of younger cohorts. This is the scenario the team deemed most credible.
- In scenario B, the team assumed that entering cohorts would have the same constellation of diseases and disabilities as the healthy cohorts from the 1990s; this scenario ignores information about disease and disability in younger cohorts.
- In scenario C, the team assumed continued improvement in the health status of the entire elderly population and of the entering cohort; this scenario has the most favorable assumptions for Medicare spending.

The team found that lower disability rates *do* translate into lower health care costs *per beneficiary* (see Table 1). Under Scenario A, in which the estimate uses information about the health status of younger cohorts, spending is projected to be $11,206 per beneficiary in 2030. In the more optimistic Scenario C, spending per beneficiary is 8 percent lower at $10,275.

However, total Medicare spending under these three sets of assumptions does not differ very much. As Figure 2 shows, by 2030, Scenario A and Scenario B differ by only 2 percent

Figure 2
Total Medicare Spending Under the Three Scenarios, 2002–2030 (2005 dollars)



SOURCE: Based on Exhibit 5 from Goldman et al., 2005.
NOTE: Dollar figures are inflated from 1999 to 2005 using the medical Consumer Price Index.

per year. Even under the most optimistic assumptions (Scenario C), the cost savings are only 6 percent.

The reason is simple: Cumulative Medicare spending is relatively unaffected by the health status of new beneficiaries because healthier people live longer. Thus they have more years in which to accumulate costs.

There is another reason that lower disability rates do not translate into lower overall Medicare spending. FEM was used to examine *relative spending* on the disabled over time. During the period 1992 through 2000, medical spending grew most rapidly among the *least disabled* community-dwelling elderly. Thus, reducing disability rates will not result in substantial Medicare savings, not only because beneficia-

ries who live longer have more time to accumulate medical costs, but also because spending increases are greater among less-disabled beneficiaries.

Effects of Technological Innovation on Medicare Spending

The discussion above assumes that the practice of medicine will not change significantly in the coming decades. But what if it did? How might technological innovation affect future Medicare spending?

To identify technologies to examine, the analysts conducted a systematic literature review and then elicited consensus from panels of distinguished experts in cardiovascular disease, cancer and the biology of aging, and neurologic disease—the three clinical domains in which innovations were judged to have the greatest potential effect on health status and costs. The team chose to analyze the 10 technologies that the experts thought were most likely to be widely adopted (see the sidebar).

The team assessed how each innovation affected spending and life years saved over the period 2002–2030, assuming that each innovation was fully adopted by 2002. Table 2 highlights the researchers' key findings. Several striking patterns emerge.

Some Technologies Will Be Extremely Expensive. For example, intraventricular cardioverter defibrillators (ICDs) are very effective for patients with life-threatening arrhythmias. A recent coverage decision expands prophylactic ICD use to patients at high risk of sudden death from ischemic cardiomyopathy. But if use is expanded to patients with other heart problems, then costs could rise very quickly. The

Key Technologies Identified by the Panels of Experts

Intraventricular cardioverter defibrillators (ICDs): devices implanted in the heart that apply a therapeutic shock when severe arrhythmias are detected.

Left ventricular assist devices (LVADs): devices implanted in the heart to help the left ventricle pump blood.

Pacemakers to control atrial fibrillation: devices implanted in the heart to control disturbances of the heart rhythm.

Telomerase inhibitors: molecules that prevent the expression of telomerase, an enzyme that allows cancer cells to replicate.

Cancer vaccines: compounds that stimulate the body's immune system to fight cancer cells.

Anti-angiogenesis: antigrowth factors that inhibit the development of new blood vessels, which tumors need to grow.

Treatment of acute stroke: drugs that would reduce a stroke's disabling effects by 50 percent.

Prevention of Alzheimer's: compounds to delay the onset of Alzheimer's.

Prevention of diabetes: drugs that would reduce health hazards associated with diabetes by 50 percent over 15 years.

Compounds that extend life: drugs that would increase life expectancy by about 10 (healthy or unhealthy) years.

Table 2
The Effects of Selected Medical Technologies on Spending and Life Years

Technology	Annual Treatment Cost, 2030 (billions of 2005 dollars)	Percentage Increase in Health Care Spending in 2030	Cost Per Additional Life Year (2005 dollars)
Antiaging compounds (healthy)	93.1	13.8	11,245
Cancer vaccines	1.0	0.4	23,330
Treatment of acute stroke	5.6	0.4	28,024
Antiaging compounds (unhealthy)	93.8	70.4	38,105
Telomerase inhibitors	8.2	0.5	79,170
Alzheimer's prevention	62.8	8.0	102,774
ICDs	26.5	3.7	131,892
Diabetes prevention	26.4	3.2	188,316
Anti-angiogenesis	66.4	8.0	638,141
LVADs	18.2	2.3	654,968
Pacemakers for atrial fibrillation	17.4	2.3	1,795,846

research team simulated the effects of expanding ICD use to half of elderly patients with new cases of heart failure or heart attack. This would result in approximately 374,000 procedures annually in 2015 and 550,000 in 2030, and total treatment costs of $14 billion and $27 billion, respectively. The cost per additional year of life would be about $132,000.

Some Technologies Improve Health but at a Very High Price. For example, anti-angiogenesis, pacemakers for atrial fibrillation, and left ventricular assist devices (LVADs) are all costly relative to their known health benefits. If these technologies are broadly applied, costs per additional life year would be very high.

Some Technologies May Have Modest Costs Per Additional Year of Life Saved, but They Will Increase Health Care Spending Substantially. For example, an antiaging compound would increase health care spending by 14 percent in 2030 because, if the compound had been taken by healthy beneficiaries starting in 2002, there would be 13 million more Medicare beneficiaries in 2030. However, the cost per additional year of life is only $11,000. If the compound is keeping unhealthy people alive longer, total health care spending in 2030 would be 70 percent higher: There would be more elderly people in poor health. The cost per additional life year of $38,000 is still relatively modest.

The case of antiaging compounds underscores the tension inherent in medical innovations: They keep people alive longer, but as a result, people incur more health care costs. Overall, however, society would consider the additional years well worth the additional dollars.

Effects of Reducing Chronic Illness on Medicare Spending

Chronic illnesses such as heart disease, cancer, and diabetes are expensive to treat. As a consequence, the relatively small proportion of Medicare beneficiaries with such diseases account for a disproportionate share of Medicare spending—perhaps as much as three-quarters of the total. Could reducing the prevalence of chronic illness among beneficiaries improve Medicare's financial outlook?

Economist Geoffrey Joyce and his colleagues used FEM to examine how seven of the most common chronic illnesses affect average life expectancy and health care spending among Medicare beneficiaries from age 65 until death. The diseases they focused on were hypertension, diabetes, cancer (lung, breast, prostate, colon, uterine, throat, bladder, kidney, and brain), chronic obstructive pulmonary disease (COPD) (chronic bronchitis, emphysema, and some forms of asthma), acute myocardial infarction, coronary heart disease, and stroke.

Table 3 highlights their key policy findings.

Table 3
Changes in Average Life Expectancy and Medical Spending Associated with Selected Chronic Conditions at Age 65

Disease Condition at Age 65	Average Reduction in Life Expectancy (years)	Average Increase in Total Health Care Spending (2005 dollars)	
		Annual	Lifetime
Stroke	3.0	1,777	4,870
COPD	2.8	1,951	7,878
Hypertension	0.3	878	12,343
Coronary heart disease	0.6	1,078	14,957
Cancer	2.1	1,787	15,709
Diabetes	3.1	2,469	16,672
Acute myocardial infarction	2.3	1,966	17,574

SOURCE: Based on Exhibit 6 in Joyce et al., 2005.
NOTE: Dollar figures are inflated from 1999 to 2005 using the medical Consumer Price Index.

Chronic diseases clearly affect both life expectancy and health care costs. Reduction in life expectancy ranges from 0.3 years for a beneficiary with hypertension to about 3 years for a beneficiary with stroke or diabetes.

All of these diseases increase annual health care costs over the cost incurred by a similar individual without the disease. However, cumulative health care spending is only modestly higher for those with chronic diseases, ranging from about $5,000 to $18,000. Put another way, beneficiaries with chronic disease do not cost Medicare a great deal more than those without such diseases because the chronically ill live fewer years.

Chronic illness has a similar effect on Medicare payments, although the level of spending is slightly lower. Annual Medicare expenses increase by about $750 to $2,000 for persons with a serious chronic illness at age 65, while cumulative Medicare expenses increase by $2,500 to $15,000 across the seven chronic conditions.

There are two primary reasons why cumulative expenditures are only modestly different for those with and without the disease at age 65. First, many beneficiaries without a condition at age 65 will develop it in subsequent years. Thus the cost savings from better health at age 65 do not accrue indefinitely. Second, the costs incurred in the final year of life are substantial and largely unchanging in relation to disease condition or age. Extending life by several years reduces the high (discounted) costs incurred prior to death, but they cannot be avoided altogether under the current system of care.

Many of these chronic diseases are preventable or their burden can be greatly reduced. Prevention and screening for these conditions could be effective public health measures. However, such efforts will only modestly reduce Medicare's future health care costs.

Effects of Cancer Treatment on Medicare Spending

Cancer is largely a disease of old age. For example, about 60 percent of cancer patients in 2001 were age 65 or older. Because cancer treatment is expensive, changes in cancer treatment would certainly affect Medicare spending. A team of analysts used FEM to project spending on cancer care among the elderly through 2030.

To capture the uncertainty about the nature of future cancer treatment, the team estimated the future costs of treatment using five widely varying scenarios of technological change:

- Cancer treatment technologies existing in 2000 remain the same until 2030.
- New drugs developed between 2000 and 2004 improve treatment outcomes.
- Cancer screening technologies improve significantly.
- A cancer vaccine is developed.
- A cure for cancer is discovered.

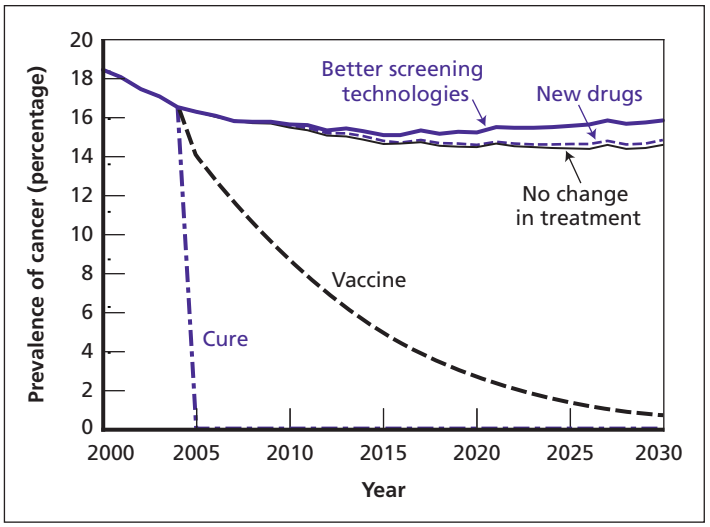
These scenarios, which range from very pessimistic to very optimistic, reflect the judgments from a panel of experts on cancer and the biology of aging. Some of the scenarios would keep some people alive long enough to contract other diseases. If these diseases are expensive to treat, a relatively inexpensive and effective cancer treatment could end up increasing Medicare spending. An important feature of FEM is its ability to model the outcomes of such competing mortality risks.

Figure 3 shows FEM's projection of cancer prevalence among the elderly, based on each of these scenarios. (Prevalence is the number of individuals age 65 and over reporting having cancer in a given year, divided by the total number of individuals age 65 and over in that year.)

If there is **no change in treatment**, cancer rates decline from close to 20 percent in 2000 to about 16 percent in 2015 and then remain unchanged through 2030. The decline reflects the fact that people aging into Medicare between 2000 and 2015 were healthier than previous beneficiaries because the former group had lower smoking rates. By 2015, this replacement process reaches a steady state.

In two cases, the scenarios increase the prevalence rate. **New drugs** could increase the survival rate, so that at any given time there would be more people alive with cancer. **Better screening technologies** would increase cancer prevalence because previously undetected cancers would be found at an early stage, and early-stage cancer patients are more likely to survive.

Figure 3
The Effects of Selected Medical Technologies on Cancer Prevalence



Both a vaccine and a cure would reduce cancer prevalence. In the case of a **vaccine**, prevalence would essentially reach zero after the remaining cancer survivors die. In the case of a **cure**, cancer prevalence would drop immediately to zero.

However, none of these scenarios would significantly affect total Medicare spending. In every case, total medical spending for the elderly will increase dramatically between 2005 and 2030 because the elderly population will increase dramatically during that period. Demographics swamp the effects of even the most impressive technological developments.

Effects of Obesity on Medicare Spending

Analysis using FEM suggests that eliminating any one disease will not dramatically affect future health care costs. But obesity might be an exception to this rule. If it is, then combating obesity could have important implications for Medicare since close to half of the U.S. population is overweight. Obesity is a "double whammy" for Medicare, because it raises annual health care expenditures but does not affect longevity and thus the number of years spent in the Medicare system.

Darius Lakdawalla and his colleagues used FEM to track the health conditions, functional status, and Medicare and total health care spending for obese and nonobese 70-year-old Medicare beneficiaries. The team divided the sample into four categories, based on body mass index (BMI): underweight (BMI 20 or less), normal (BMI 20–24.9), overweight (BMI 25–29.9), and obese (BMI 30 or more). (BMI is weight

in kilograms, divided by height in meters squared.) For each weight class, they predicted three sets of health indicators: expected years spent healthy or frail, prevalence of disease in old age, and medical spending in old age.

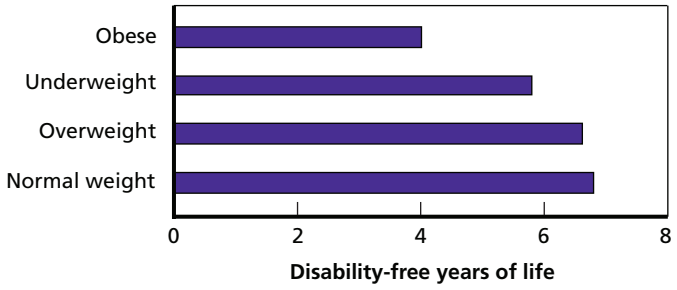
The research team found no difference in overall life expectancy between an obese 70-year-old and one of normal weight. However, weight has a strong effect on the number of disability-free years that a 70-year-old can expect (see Figure 4). The obese can expect only four disability-free life years. They will spend 40 percent more time disabled than their normal-weight counterparts, who can expect nearly seven years without disability.

Greater disability translates into higher health care spending. Figure 5 highlights the high costs to Medicare of obese beneficiaries.

Starting at age 70, an obese person will cost Medicare about $149,000, the highest level of any group. Medicare spending on an obese person is 20 percent higher than for the next closest group, the overweight, and 35 percent higher than spending on a person of normal weight. Thus, Medicare could experience considerable financial burden from the increase in obesity nationwide, spending about $38,000 more over the lifetime of an obese 70-year-old than it will spend on a beneficiary of similar age and normal weight.

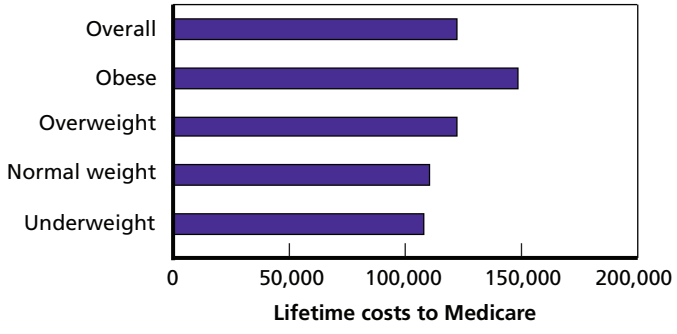
However, Lakdawalla and his colleagues argue that the disability effects of obesity, rather than increased spending, might be the more important component of the social burden of obesity.

Figure 4
How Weight Affects Disability



SOURCE: Data are drawn from Lakdawalla et al., 2005.

Figure 5
Projected Lifetime Costs to Medicare (2005 dollars)



SOURCE: Data are drawn from Exhibit 3 in Lakdawalla et al., 2005.
NOTE: Dollar figures are inflated from 2004 to 2005 using the medical Consumer Price Index.

The Value of Preventing Disease Among the Elderly

The studies summarized above suggest that medical innovations will improve health and extend life but are likely to increase rather than decrease Medicare costs. In addition, with the possible exception of obesity, eliminating any one disease will not save Medicare money. But what about forestalling expensive diseases? The panel of experts described above who identified the medical technologies most likely to affect the health of the future elderly noted that the most dramatic improvements in population health would result from lifestyle changes and better prevention.

Dana Goldman and his team used FEM to explore the nature and magnitude of such improvements. The researchers examined the cost and health effects of reducing/eliminating the key risk factors linked to heart disease, one of the leading causes of mortality among the elderly. The risk factors they modeled—hypertension, smoking, obesity, and diabetes—were identified by the expert panel as the areas where prevention could have the greatest potential effects.

To determine the greatest possible benefit from prevention, the team made the following assumptions:

- Hypertension is effectively treated in all elderly.
- A smoking cessation program is 100 percent effective.
- Rates of obesity are cut in half, returning them to levels in the 1980s.
- Diabetes is perfectly controlled.

Identifying how prevention efforts affect costs and health involves tracking complex interactions between clinical outcomes and demographic trends. For example, a completely successful smoking cessation program does not substantially reduce heart disease among the elderly because (1) smoking cessation is less effective in reducing heart disease among the elderly and (2) not smoking keeps people alive somewhat longer and age, by itself, puts people at risk for heart disease.

The analysts combined health and population changes into an overall effect—disability-adjusted life years (DALYs). Table 4 highlights some of the potential benefits of prevention in terms of both DALYs and spending for the 108 million

Table 4
Effects of Prevention on the Health and Spending of Medicare Entrants, 2005–2030

	Changes in Total DALYS (millions)	Change in Total Spending (billions)
Hypertension is eliminated	75.3	–890
The smoking cessation program is 100 percent effective	32.4	293
Obesity is reduced by 50 percent	16.4	–1,201
Diabetes is perfectly controlled	90.0	246

Medicare beneficiaries who will enter the program between 2005 and 2030.

Eliminating hypertension would result in 75 million additional DALYs and reduce total Medicare spending by about $890 billion. Perfectly controlling diabetes would result in even more additional DALYs; however, spending would increase. Why? Because individuals who develop diabetes are sicker before its onset than people who develop hypertension, so eliminating diabetes keeps these "more-expensive" people alive longer. On the other hand, perfectly controlling hypertension reduces heart disease, which is expensive to treat.

Because FEM makes it possible to model the results of competing health outcomes and mortality risks, it provides insights about the most effective allocation of prevention resources, depending on the goal. For example, as noted above, obesity has no effect on mortality. However, it does affect both heart disease and diabetes. In fact, it is this pattern that produces the large reductions in medical spending shown in Table 4 when obesity is substantially reduced. Reduced obesity does not keep people alive very much longer, so they do not have more time to incur medical costs, but the years that they do live will be relatively disability free. So if the goal of obesity prevention is to save lives, then interventions have to happen early; if the goal is to reduce costs, interventions can wait until obese people are older.

Ongoing Applications of the Future Elderly Model

FEM is a powerful, flexible tool enabling policy analysts to understand future trends in health, health spending, medical technology, longevity, labor supply, and earnings. It is being used to examine such trends in individuals over age 50 in the United States and seven European countries (Germany, Sweden, the Netherlands, Spain, Italy, France, and Denmark). For example, analysts are using FEM to investigate how a reduction in smoking will affect the Social Security trust funds. FEM is also being used to examine how market size and pricing policies affect future innovation in the pharmaceutical industry and how alternative policy schemes affect the future health and welfare of consumers. With such efforts, policymakers will be better equipped to design social programs that improve health with the least possible public and private expenditures. ■

This Highlight summarizes RAND Health research reported in the following publications:

Bhattacharya J, Shang B, Su CK, Goldman DP, "Technological Advances in Cancer and Future Spending by the Elderly," *Health Affairs—Web Exclusive*, September 26, 2005, pp. W5-R53–W5-R66.

Chernew ME, Goldman DP, Pan F, Shang B, "Disability and Health Care Spending Among Medicare Beneficiaries," *Health Affairs—Web Exclusive*, September 26, 2005, pp. W5-R42–W5-R52.

Goldman DP, Cutler DM, Shang B, Joyce GF, "The Value of Elderly Disease Prevention," *Forum for Health Economics & Policy*, Vol. 9, No. 2, (Biomedical Research and the Economy), Article 1, 2006, available at: http://www.bepress.com/fhep/biomedical_research/1

Goldman DP, Shang B, Bhattacharya J, Garber AM, Hurd M, Joyce GF, Lakdawalla DN, Panis C, Shekelle PG, "Consequences of Health Trends and Medical Innovation for the Future Elderly," *Health Affairs—Web Exclusive*, September 26, 2005, pp. W5-R5–W5-R17, available at: http://content.healthaffairs.org/cgi/content/abstract/hlthaff.w5.r5v1

Goldman DP, Shekelle PG, Bhattacharya J, Hurd M, Joyce GF, Ladkawalla DN, Matsui DH, Newberry SJ, Panis CWA, Shang B, *Health Status and Medical Treatment of the Future Elderly: Final Report*, Santa Monica, Calif.: RAND Corporation, TR-169-CMS, 2004, available at: http://www.rand.org/publications/TR/TR169/

Joyce GF, Keeler EB, Shang B, Goldman DP, "The Lifetime Burden of Chronic Disease Among the Elderly," *Health Affairs—Web Exclusive*, September 26, 2005, pp. W5-R18–W5-R29.

Lakdawalla DN, Goldman DP, Shang B, "The Health and Cost Consequences of Obesity Among the Future Elderly," *Health Affairs—Web Exclusive*, September 26, 2005, pp. W5-R30–W5-R41.

Shekelle PG, Ortiz E, Newberry SJ, Rich MW, Rhodes SL, Brook RH, Goldman DP, "Identifying Potential Health Care Innovations for the Future Elderly," *Health Affairs—Web Exclusive*, September 26, 2005, pp. W5-R67–W5-R76.

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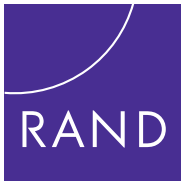
RB-9324 (2008)



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