RAND REVIEW

Fall 2005 Vol. 29, No. 3

# Many Happy Returns

## *Early Childhood Programs Entail Costs, but the Paybacks Could Be Substantial*

**—By Lynn A. Karoly, M. Rebecca Kilburn, Jill S. Cannon, James H. Bigelow, and Rachel Christina**

**In Search of Energy Security: Will New Sources and Technologies Reduce Our Vulnerability to Major Disruptions?**
**—By James T. Bartis, Mark A. Bernstein, Tom LaTourrette, and Debra Knopman**

**Bulging Repertoires: Treatments and Complications for the Overweight and Obese Expand with the Population**
**—By Margaret Maglione, Lisa Shugarman, and Melony Sorbero**

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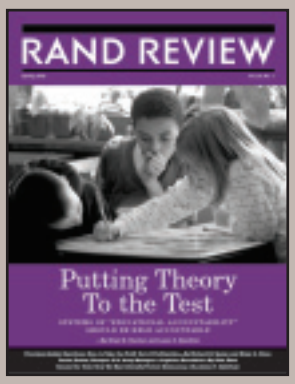

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# Message from the Editor

Both lead stories in this issue promote long-term investment strategies. The cover story outlines the wisdom of bearing the up-front costs for publicly funded high-quality early childhood intervention programs so that society can reap the plentiful returns, even if they take years to accumulate. The story on energy security argues for a vastly diversified national energy investment portfolio to help reduce economic vulnerability to energy supply shocks over the next several decades.

Our centerpiece illustrates the point with respect to early childhood interventions: The programs can pay off for decades to come. The payoffs have been demonstrated for a range of program types—home visiting, parent education, and early childhood education—and for those that serve disadvantaged children as well as for those that serve everyone. Even the short-term evaluations have often shown positive net returns. Meanwhile, the long-term evaluations have shown that the investments have continued to pay dividends over the lifetimes of the participants.

Our story on energy security conveys the point in starker terms, befitting of this particular challenge: There is no quick fix. The best short-term way to increase America's energy security is to increase America's energy efficiency. But for the long haul, efficiency is insufficient. Only a mixture of energy investment options with different time horizons stretching out over the next 25 to 50 years can help the United States keep pace with its growing energy demands and reduce the risks inherent in its currently limited energy investment portfolio.

Neither of these stories offers a tremendous amount of fodder for short-term political gain. But both stories offer hearty portions of guidance for long-term public policy improvements.

—John Godges

**On the Cover**

Kira Rivet, left, and Elijah Martineau, both 4, embrace as they sing at the Lad & Lassie Preschool at Mount Hope Presbyterian Church in Lansing, Mich., in May.
AP/AL GOLDIS

RAND REVIEW
Fall 2005 Vol. 29, No. 3

4 *News*
- What English patients want
- What American doctors need
- What U.S. taxpayers do not cover
- What the Chinese should not export

8 *Perspectives*
**Best of Both Worlds?**
A View of the Changing Workplace

10 COVER STORY
**Many Happy Returns**
Early Childhood Programs Entail Costs, but the Paybacks Could Be Substantial
*By Lynn A. Karoly, M. Rebecca Kilburn, Jill S. Cannon, James H. Bigelow, and Rachel Christina*

16 ***Centerpiece*—A Variety of Early Childhood Interventions Have Generated Favorable Economic Returns**

18 **In Search of Energy Security**
Will New Sources and Technologies Reduce Our Vulnerability to Major Disruptions?
*By James T. Bartis, Mark A. Bernstein, Tom LaTourrette, and Debra Knopman*

24 **SIDEBAR: Better Resource Assessments Would Improve Resource Development**

26 **Bulging Repertoires**
Treatments and Complications for the Overweight and Obese Expand with the Population
*By Margaret Maglione, Lisa Shugarman, and Melony Sorbero*

# What People in England Want When Choosing Their Own Hospitals

RAND Europe researchers in the Cambridge office have found that, contrary to expectations, people in London consider factors beyond just waiting time when given the chance to choose their own hospitals. Although health care is free in England, people historically have had to use hospitals chosen by their general practitioners and have often endured long waiting lists.

Researchers evaluated a pilot program, known as the London Patient Choice Project, conducted by the National Health Service (NHS). The researchers asked patients to choose between their home hospital and an alternative hospital depending on several variables: the waiting time at each hospital, the travel time to each, whether transportation to the alternative hospital was paid for by NHS or by the patient, the reputation of the alternative hospital, and the location of any follow-up care.

"Shorter waiting time is clearly important to patients, but the choice for quicker treatment depends crucially on whether patients can avoid traveling abroad to an alternative hospital outside the United Kingdom and whether they can avoid treatment at a hospital where the reputation is worse or unknown relative to their current hospital," said Peter Burge, lead author of the study.

The figure shows the importance that patients place on the hospital's reputation relative to waiting time. The top two panels show that if the reputation of the alternative hospital is worse than the home hospital or unknown, patients are willing to wait rather than switch and that those with higher incomes are willing to wait longer. The bottom panel shows that if the alternative hospital has a better reputation, patients are willing to wait to switch to it and that their willingness to wait is sensitive to how much better that reputation is.

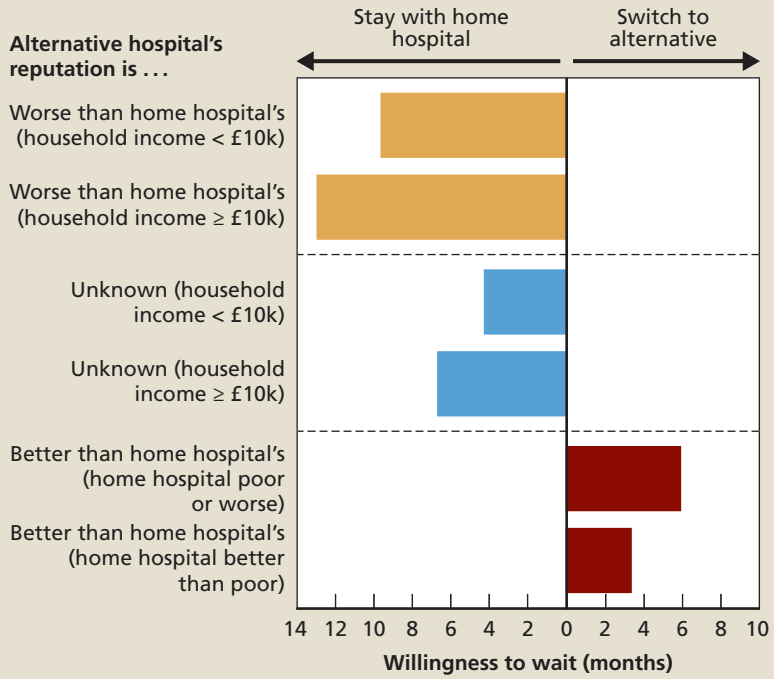
Looking at differences by individual group, the study also showed that patients are less likely to select faster treatment elsewhere if they are older, female, have low education levels, or are parents or guardians of minors.

The study raises a number of key policy implications. First, patients need more information about quality and reputation of alternative providers. Second, if the goal is to encourage movement to alternative providers outside the patient's local area, then the NHS should arrange and pay for transportation to alternative hospitals. Finally, follow-up care should be provided at the home hospital to minimize the negative value that patients place on switching to an alternative hospital. ■

For more information: *London Patient Choice Project Evaluation: A Model of Patients' Choices of Hospital from Stated and Revealed Preference Choice Data*, 2005, available online only at www.rand.org/publications/TR/TR230.

**If the reputation of the alternative hospital is worse than the home hospital or unknown, patients are willing to wait rather than switch.**

**Reputation Is Very Important in Choosing Hospitals**




SOURCE: *London Patient Choice Project Evaluation*, 2005.

# Time Is Right to Promote Health Information Technology, Study Finds

Despite investing more than $1.7 trillion annually in health care, the U.S. health care system is inefficient and frequently fails to deliver recommended care. But the "widespread adoption of health information technology could greatly improve health and health care in America while yielding significant savings," according to Richard Hillestad, a RAND management scientist and lead author of a new study published in the September/October issue of *Health Affairs*.

The study shows that health information technology (HIT) systems can yield dramatic efficiency savings, greatly increased safety, and health benefits. The largest efficiency savings come from reduced hospital stays, reduced nurses' administration time, and more-efficient drug utilization.

Increased safety results largely from alerts and reminders generated by computerized physician-order-entry systems for medications. For example, if all hospitals had such a system, around 200,000 adverse drug events could be eliminated each year, at an annual savings of about $1 billion.

As for health benefits, HIT systems facilitate prevention by identifying patients who are due for routine screening tests or who require changes in the management of a chronic disease. For example, increasing the pneumonia vaccination rate could prevent between 15,000 and 27,000 deaths annually at a cost of $90 million.

The figure shows net potential savings (total savings minus total costs) from increased efficiency over a 15-year period, the amount of time generally required for full adoption of a new technology. By 2018, annual net savings for both inpatient and outpatient care could be about $65 billion per year. These net savings are from increased efficiency alone; health and safety benefits could double the net savings.

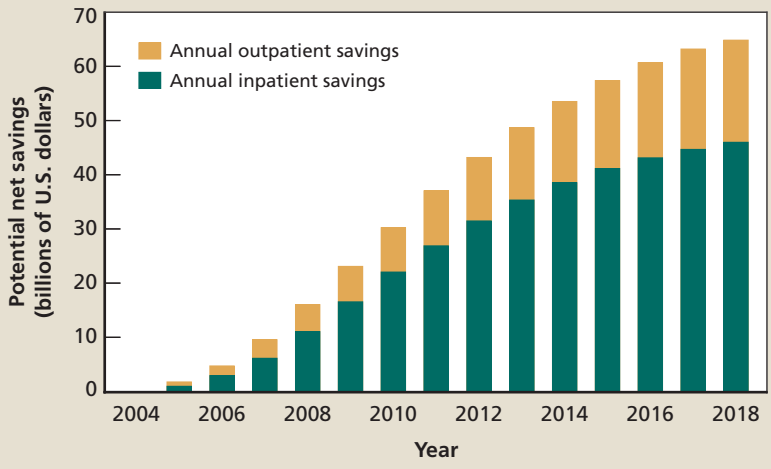
Despite the promise of savings, relatively few health providers have adopted HIT. Only about 20 to 25 percent of hospitals and 15 to 20 percent of physicians' offices have HIT systems, and those systems are generally limited in their ability to share information with other providers.

"One of the most serious obstacles to investing in HIT is that those who pay for it (providers) don't necessarily experience the savings," Hillestad said. In fact, many providers pay twice, both in terms of higher costs to implement HIT and in lower revenues after implementation.

"We need to find ways to reward health providers who invest in measures that boost efficiency and promote quality. Government action is needed," stressed Hillestad. "Without such action, it may be impossible to overcome such market obstacles." ■

**"Government action is needed. Without such action, it may be impossible to overcome . . . market obstacles."**

**Estimated Net Savings from Increased Efficiency Would Grow Substantially over 15 Years**




SOURCE: "Can Electronic Medical Record Systems Transform Healthcare? An Assessment of Potential Health Benefits, Savings, and Costs," *Health Affairs*, Vol. 24, No. 5, September/October 2005, pp. 1103–1117, Richard Hillestad, James Bigelow, Anthony Bower, Federico Girosi, Robin Meili, Richard Scoville, Roger Taylor.

NOTE: The authors assume full adoption of health information technology by 90 percent of hospitals and doctors' offices at the end of 15 years.

## Terrorism Risk Insurance Act Can Distribute Financial Losses Effectively

Given the massive financial losses after the 9/11 terrorist attacks, concerns have arisen about the potential financial impact of another large terrorist attack on U.S. soil. But there is some good news to report.

"The nation's terrorism insurance system creates an effective mechanism for sharing the financial risk that businesses face from terrorism," said Stephen Carroll, a RAND economist and lead author of a new study.

After 9/11, Congress passed the Terrorism Risk Insurance Act (TRIA), which requires insurers to make terrorism coverage available to commercial policyholders. The legislation will expire at the end of 2005 unless Congress extends it.

To assess how well TRIA would work, RAND researchers simulated the expected losses from three types of terrorist attacks: (1) the crash of a hijacked aircraft into a major office building, (2) the release of anthrax within a major office building, and (3) the release of anthrax outdoors in a major urban area. The researchers then assessed how TRIA would distribute the resulting losses.

The study found that losses would vary substantially in size, with losses from the outdoor anthrax scenario ($172 billion) dwarfing those from the aircraft impact ($7 billion) and indoor anthrax ($8 billion) scenarios.

**TRIA is not, as some have suggested, a taxpayer bailout of the insurance industry.**

For eligible losses under TRIA, commercial insurers would be responsible for payouts up to an annual deductible and, in addition, for a co-payment of 10 percent of all losses above the deductible. Beyond that, the federal government (taxpayers) would step in and reimburse the commercial insurers for remaining covered losses up to $100 billion. However, the government would recoup some of this reimbursement through a surcharge on all U.S. commercial policyholders.

The figure shows what would happen under the three scenarios. Uninsured businesses would incur a large portion of the losses in every case. Life and health insurers, which are not covered under TRIA, would also pay for some losses.

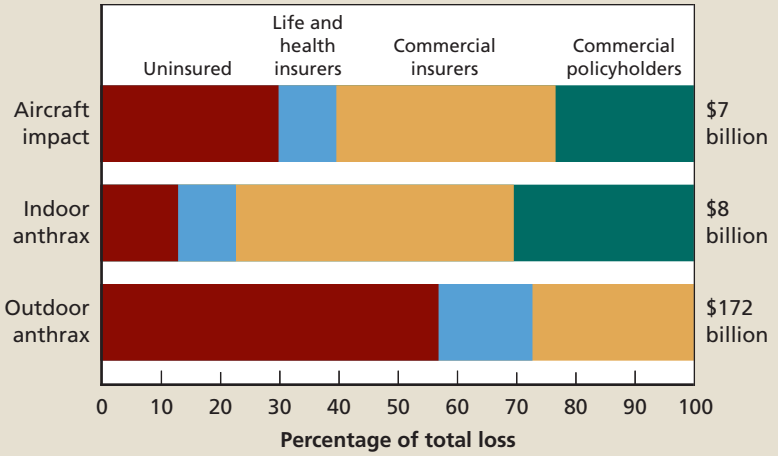
How TRIA would distribute the covered losses varies by scenario. For the aircraft impact and indoor anthrax scenarios, commercial insurers and commercial policyholders (through the surcharge) would pay all the remaining losses from a single attack. For the outdoor anthrax scenario, the entire remaining burden for the attack would fall on commercial insurers.

"What's notable is that taxpayers would likely pay for no losses in any of the scenarios," noted Tom LaTourrette, another study author. As such, TRIA is not, as some have suggested, a taxpayer bailout of the insurance industry.

Also notable is that fewer than half of all businesses have yet to buy terrorism insurance, even though TRIA makes it more available and affordable. Given how much of the losses would go uninsured in the three scenarios, the study suggests that the federal government consider encouraging uninsured businesses to buy terrorism insurance. ■

For more information: *Distribution of Losses from Large Terrorist Attacks Under the Terrorism Risk Insurance Act*, ISBN 0-8330-3865-6, 2005.

**Under TRIA, Who Would Pay for Losses Incurred in Three Scenarios?**




SOURCE: *Distribution of Losses from Large Terrorist Attacks Under the Terrorism Risk Insurance Act*, 2005.

## China Should Go Further in Controlling WMD Exports, Report Argues

With terrorists seeking weapons of mass destruction (WMD), it is all the more critical to control exports of sensitive goods and technologies that could be used to help create chemical, biological, radiological, and nuclear weapons. This concern is especially applicable to China, according to a new RAND report.

In the last ten years, China has gradually erected a legal structure to control the export of goods that can be used in making WMD, "but it hasn't devoted the necessary financial or political resources to make these controls fully effective," said Evan Medeiros, a RAND political scientist.

His study relies on numerous sources, including publicly available Chinese-language materials plus interviews with Chinese government officials, analysts, and businessmen directly involved in the country's export control process. The study traces the evolution of China's export control system and assesses its strengths and weaknesses.

According to the study, China's export control system has evolved significantly over the past 25 years, moving from highly underdeveloped and ineffective administrative procedures to a comprehensive collection of laws, regulations, and measures that incorporate prevailing standards for international export control. Many factors have influenced this evolution, including changes in Chinese leaders' views about the contributions of nonproliferation to Chinese foreign policy and national security, along with international pressure, mostly from the United States.

Despite these gains, the Chinese government has been unable to consistently and effectively enforce its new controls, which is "a persistent and glaring weakness of the current system," said Medeiros. The Chinese government has publicized only two cases of export control violations where penalties were assessed, generating little incentive for Chinese companies to comply with the laws.

The study cites a number of additional concerns:

- Foreign agents and enterprises operating in China have taken advantage of the weak regulatory environment to illicitly procure controlled items for their national WMD-related development programs.
- As a result of China's membership in the World Trade Organization, foreign involvement in China's domestic nuclear, aerospace, and chemical industries will grow and could become a matter of concern for China's export control system.
- China's current antiproliferation mechanisms are largely reactive and rely heavily on reports and tips from Western intelligence officials about pending exports of controlled goods and technologies.
- Chinese Ministry of Commerce officials appear unwilling to pursue investigations of alleged wrongdoing against large and influential Chinese state-owned enterprises with strong political connections.

The study concludes that further improvements will be gradual and mixed unless the Chinese government devotes more resources and political capital to bolstering its export controls. How much effort the government devotes will be a key indicator of the government's ability to fulfill its stated goal of acting like a "responsible major power" in global affairs, especially as related to WMD nonproliferation, says the report. ■

For more information: *Chasing the Dragon: Assessing China's System of Export Controls for WMD-Related Goods and Technologies*, ISBN 0-8330-3805-2, 2005.

**China "hasn't devoted the necessary financial or political resources to make these controls fully effective."**

# Best of Both Worlds?

## A View of the Changing Workplace

HISTORICALLY, WORKERS HAVE FACED A CHOICE. They could toil for large corporations, with all the benefits—stable employment, health insurance, and pension plans—but also with the downside of hierarchical structures, especially the rigid command and control from above. Or they could work for small organizations or for themselves, enjoying more freedom in controlling their own efforts and setting their own rules and schedules but lacking the economic stability provided by large corporations with their economies of scale and associated perks.

Nowadays, however, we are witnessing the harbingers of a working world in which we may be able to have it both ways: the economic benefits of large corporations and the human benefits of small organizations. Such harbingers signal the "early stages of increases in human freedom for business," according to Thomas Malone, the Patrick J. McGovern Professor of Management at the MIT Sloan School of Management and author of the new book *The Future of Work*. These increases in freedom "may, in the long run, be as important for business as the change to democracies was for governments," said Malone, who spoke at RAND as part of a panel on the future of work.

What's making this possible, he continued, is a growing decentralization in businesses enabled by a new generation of information technology—such as the Internet, the World Wide Web, and email—that is driving down the cost of communications. One manifestation of this trend is the growing number of workers who are able to do their jobs by telecommuting, or working off-site in "virtual offices."

The trend portends even more significant changes for business. As Malone noted, the low costs of communications in organizations are leading to decentralization in decisionmaking itself, such that large numbers of people in large organizations have enough information to make sensible decisions for themselves instead of being told what to do by someone above them in a hierarchy who supposedly knows more than they do. The "quality circles" that have emerged in some factories in recent decades reflect this "pushing down" of decisionmaking authority.

When people make decisions for themselves, they tend to be more highly motivated and dedicated, more creative, and more flexible. "They simply like it better," said Malone. Of course, such decentralization is not always appropriate in modern business. For a company making semiconductors, for example, the key will still be achieving economies of scale.

**In our increasingly knowledge-based, information-driven economy, the critical factors for business success are often precisely the same as the benefits of decentralized decisionmaking: dedication, creativity, and innovation.**

### We Have Seen the Future, and It Is eBay

But in our increasingly knowledge-based, information-driven economy, the critical factors for business success are often precisely the same as the benefits of decentralized decisionmaking: dedication, creativity, and innovation. A prime example of the change we are seeing in business today is eBay. With faster revenue growth since its founding than any company in history, eBay now has 56 million active buyers and sellers.

What is even more telling is that 430,000 of those sellers make their primary living from selling on eBay. "If those 430,000 people were actually eBay employees," said Malone, "eBay would be the second largest private employer in the country, after Wal-Mart but ahead of McDonald's."

eBay has used cheap communication provided by information technology to invent a new way to do retailing. In effect, it has outsourced almost all the functions of retailing—merchandising, customer service, order fulfillment—to independent sellers,

who are not eBay employees or even contractors. eBay doesn't pay them at all—they pay eBay.

In many ways, eBay has achieved the best of both possible worlds. Its sellers are independent storeowners who have a vast amount of freedom to decide for themselves what to sell, when to sell, how to advertise, and how to price. Yet through eBay, they enjoy a key benefit of economic scale: They can serve a global marketplace. In return, eBay ends up being a very effective and profitable retail organization.

The decentralization brought on by changes in information technology also opens up opportunities for many types of workers who are often left out of the current workplace, such as the elderly, working mothers, and those with disabilities. In fact, a 2004 RAND report on the future of work found that slower U.S. labor force growth will require employers to bring such typically underrepresented groups into the workplace, and the shift toward decentralization could assist employers in this regard.

A world of increasingly independent workers does pose challenges, the most prominent of which is that such workers will have no obvious place to obtain the benefits that they traditionally have obtained from employers. One way to deal with this challenge, according to Malone, is with the rise of a new kind of private organization whose job it will be to fulfill the needs of such workers.

Malone likens these new organizations to "guilds" and envisions them as providing a stable home for workers who move across jobs, companies, and employers. For perhaps a percentage of a worker's income in good times, these organizations could provide financial security in difficult times, as well as health insurance, job training, and even a place to socialize or to cultivate a sense of identity.

## Beyond Business As Usual

To take advantage of this new work paradigm, corporate managers must figure out how to invent new kinds of business models that are as different in their industries as eBay is in retailing. More important, Malone noted, managers must move from their traditional roles of "command and control" to more flexible roles of "coordinate and cultivate."

He also argued that government regulators should realize that some of the more important kinds of work will increasingly be done by people who are independent contractors or self-employed businesspeople (such as "e-lancers"). As such, the workplace playing field should be leveled for such workers in terms of changes in the tax code and other benefits.

At an even broader societal level, educators should move from training children how to follow orders in factories and in bureaucracies to training children how to figure out for themselves what needs to be done, how to assemble the resources to do it, and how to collaborate with others to get it done—as eBay sellers do. ■

DIANE BALDWIN

*Thomas Malone, professor at the MIT Sloan School of Management and author of* The Future of Work, *discusses the transforming workplace with guests at a RAND seminar.*

# Many Happy Returns

## *Early Childhood Programs Entail Costs, but the Paybacks Could Be Substantial*

**By Lynn A. Karoly, M. Rebecca Kilburn, Jill S. Cannon, James H. Bigelow, and Rachel Christina**

*Lynn Karoly is a senior economist at RAND. Rebecca Kilburn and Jill Cannon are director and associate director, respectively, of RAND Child Policy. James Bigelow is an operations research analyst at RAND, and Rachel Christina is a RAND consultant.*

For four decades, scientific research has sought to determine if early childhood intervention programs such as home visiting, parent education, and early childhood education—alone or in combination—could yield long-term benefits for participating children and families. Lifelong benefits could include increases in academic achievement (test scores), educational progress (timely promotion), educational attainment (years of schooling completed), behavioral and emotional competencies, health, employment, and earnings; and decreases in child abuse and neglect, delinquency and crime, and use of social welfare programs.

Almost all the early childhood programs studied so far have focused on children "at risk." Common risks involve living in poverty, having a single parent, having a mother with less than a high school education, and living in a family whose primary language is not English. Nearly half of entering U.S. kindergartners face at least one of these risk factors. Nearly one in six is subject to more than one.

For the substantial percentage of children who are disadvantaged in these ways, there is now a critical mass of completed scientific research to answer the underlying question of whether early childhood intervention programs can yield long-term benefits for participating children and families. We have compiled solid evidence that investments in high-quality early childhood programs do promote healthy physical, mental, social, and emotional development in the numerous ways described above among children at risk, improving their subsequent life outcomes during school age and beyond.

Two additional questions facing policymakers today are whether such programs would still be good investments if they were provided for *all* children, not just those in greatest need, and whether doing so is feasible. Recent RAND research has attempted to help answer these two additional questions as well.

First, we estimated the costs and benefits of one strategy for investing in an early childhood program for all: high-quality universal preschool, specifically in the state of California. We found that such an investment would indeed generate large positive net returns to society.

Second, we examined a range of state efforts to expand preschool, exploring the implementation choices made and some of the lessons that can be

learned. While we found that there are significant challenges to the implementation of high-quality universal preschool programs, we believe that the challenges can be overcome.

We summarize our findings as follows:

- Well-designed early childhood interventions have been found to generate short- and long-term benefits to participating children and families in multiple domains of well-being. When these benefits are valued in dollar terms, the return to society ranges from $1.26 to $17.07 for each dollar spent. The benefits that translate into the largest dollar values—educational attainment, earnings, and crime reduction—often accrue later in life. The best outcomes seem to be associated with programs that offer children better-trained caregivers, smaller child-to-staff ratios, and greater intensity of services.
- Investing public money to make high-quality preschool available to every 4-year-old in California would generate an estimated $2 to $4 in benefits to society for every dollar spent. The cost of such a program would be more than offset by (1) a decline in the amount of special education services provided, (2) decreased grade repetition, (3) reduced youth and adult crime, and (4) increased lifetime earnings as a result of higher educational attainment, along with the associated tax revenues. The benefits would require several years to pay off, but they would be big enough to be worth waiting for (at anything less than a 10-percent annual discount rate).
- Solid evidence does not yet exist about the best strategies for "scaling up" early childhood programs at a statewide level. Uneven or confused systems of state governance, program provision and support, and accountability can present unique challenges, particularly for states in transition from targeted to universal preschool programs. We suggest some ways to overcome these challenges, from reorganizing state bureaucracies to raising public awareness that investment in early childhood programs should *not* be justified entirely, or even primarily, on their academic benefits alone.

## Numerous Investment Options

We found rigorous evaluations of 20 early childhood programs serving disadvantaged children in the United States (see the table). Four evaluations followed many or all participants only until ages 2 or 3, giving no indication of the ultimate effects of the programs on school performance or later success. The remaining 16 evaluations measured outcomes at the time of kindergarten entry or beyond, sometimes well into adulthood.

**Well-designed early childhood interventions have been found to generate short- and long-term benefits to participating children and families in multiple domains of well-being.**

Significant and often sizable benefits were demonstrated for 19 of the 20 programs. In some cases, the benefits were demonstrated soon after the program had ended. In other cases, the benefits were observed throughout adolescence and in the transition to adulthood. In one case, lasting benefits were measured 35 years after the intervention had ceased.

Based on the results from these programs and other evidence in the research literature, there is some basis for identifying program features that are associated with more effective interventions. First, better-trained caregivers appear to generate stronger program outcomes. In the context of center-based programs, more favorable effects have been found when lead teachers have a college degree as opposed to no degree. Home visiting programs also appear to fare better with a trained nurse as opposed to a paraprofessional home visitor.

Second, for center-based programs, evidence suggests that programs with smaller child-to-staff ratios are more successful. Third, programs that provide a more intensive set of services are associated with better outcomes, but the evidence does not allow us to determine the optimal number of program hours or how that number might vary for children from various subgroups.

Of the 20 rigorously evaluated programs, one of them, the Comprehensive Child Development Program, was not shown to be effective. A second program, the Infant Health and Development Program, showed favorable outcomes as of the final follow-up at age 8, but the outcomes could not be translated into dollar savings. For the other programs, the estimates of net benefits to society ranged from about $1,400 per child to nearly $240,000 per child. In terms of benefit-cost ratios, the returns to society for each dollar spent ranged from $1.26 to $17.07 (see the centerpiece on pp. 16–17).

| Rigorous Evaluations Exist of 20 Early Childhood Intervention Programs | | | |
|---|---|---|---|
| **Program** | **Type** | **Reach** | **Initial year of evaluation** |
| Carolina Abecedarian Project | Combination (home visiting/ parent education combined with early childhood education) | One site in North Carolina | 1972 |
| Chicago Child-Parent Centers | Combination | Chicago, Ill. | 1983 |
| Comprehensive Child Development Program | Combination | Nationwide demonstration projects | 1990 |
| DARE to be You | Parent education | Western states | 1991 |
| Developmentally Supportive Care: Newborn Individualized Developmental Care and Assessment Program | Home visiting | National | 1979 |
| Early Head Start | Combination | National | 1995 |
| Early Training Project | Combination | Murfreesboro, Tenn. | 1962 |
| Head Start | Combination | National | 1967 |
| High/Scope Perry Preschool Project | Combination | Ypsilanti, Mich. | 1962 |
| HIPPY (Home Instruction Programs for Preschool Youngsters) USA | Parent education/home visiting | Multiple states | 1990 |
| Houston Parent-Child Development Center | Combination | Houston, Tex. | 1970 |
| Incredible Years | Parent education | Multiple states | Mid-1990s |
| Infant Health and Development Program | Combination | Eight sites | 1985 |
| Nurse-Family Partnership Program | Home visiting | Multiple states | 1978 |
| Oklahoma Pre-K | Early childhood education | Oklahoma | 2001 |
| Parents as Teachers | Parent education/home visiting | National | 1991 |
| Project CARE (Carolina Approach to Responsive Education) | Combination | One site in North Carolina | 1978 |
| Project CARE | Home visiting | One site in North Carolina | 1978 |
| Reach Out and Read | Parent education | National | 1996 |
| Syracuse Family Development Research Program | Combination | Syracuse, N.Y. | 1969 |
| SOURCE: *Early Childhood Interventions*, 2005. | | | |

There were positive net benefits for programs that required a large investment (over $40,000 per child), for those that cost considerably less (under $2,000 per child), and for those in between. Likewise, there were favorable economic returns for programs that focused on parent education or home visiting, as well as for those that combined such services with early childhood education.

The largest benefit-cost ratios were associated with the programs that included longer-term follow-up data. Although the programs with evaluations that followed children only until kindergarten or a few years beyond typically did not measure the outcomes that are likely to be associated with the largest dollar benefits—educational attainment, delinquency and crime, and earnings—these programs might eventually generate these benefits as well.

Not all benefits could be translated into dollars. Therefore, the benefit estimates are likely to be conservative. The estimates generally did not account for any improved labor market performance among the parents of participating children or for economy-wide advantages that might result from the improved educational attainment of the workforce.

The returns were likely to be higher in those programs that targeted disadvantaged children than in those that served lower-risk children. In the Nurse-

Family Partnership home visiting program, for example, the return for each dollar invested was $5.70 from a higher-risk population but only $1.26 from a lower-risk population.

It is unreasonable to expect the returns for a program serving a disadvantaged population to be matched when the same program serves a broader population. We certainly would not expect to see the same returns in a universal program, such as a state-run preschool program available to all. Nevertheless, the net benefits for universal programs could still be positive.

## Universal Preschool

Preschool is an increasingly common experience for children in the United States. In 2001, 43 percent of 3-year-olds and 66 percent of 4-year-olds were enrolled in some form of preschool nationwide. These percentages are three times as high for 3-year-olds and twice as high for 4-year-olds as they were in 1970.

However, there are wide variations in enrollment rates based on race, ethnicity, family income, and parental education. One of the sharpest contrasts is by mothers' education. Among 3- to 5-year-olds whose mothers have not finished high school, just 38 percent are enrolled in preschool, compared with 70 percent of those whose mothers have at least a college degree (see Figure 1).

There is growing interest in California and across the country in providing universal access to voluntary public preschool (that is, access for all children in a predetermined age range whose parents wish them to attend). Californians will likely have an opportunity in June 2006 to vote on a ballot initiative that would mandate and fund universal preschool statewide.

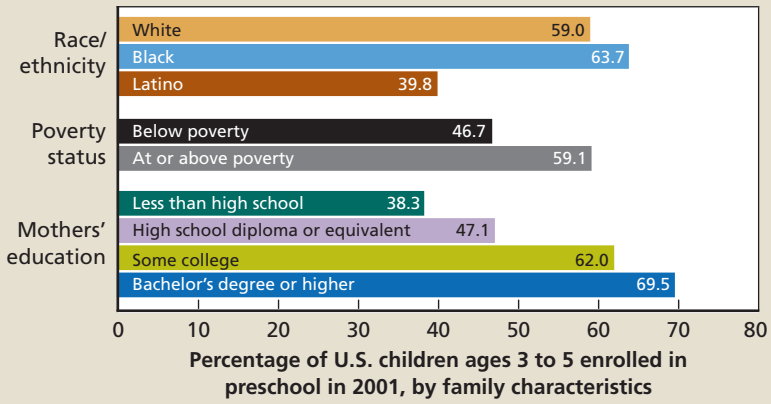
In estimating the costs and benefits of such an effort, we assumed a high level of program quality statewide, meaning the program would meet nationally recognized standards for class size, staff ratio, staff qualifications, and other features associated with better outcomes for children. We assumed that a part-day, voluntary program would enroll 70 percent of the state's 4-year-olds.

We found that universal preschool would cost $5,700 per child, but the incremental cost would be $4,300 after accounting for current spending for public preschool programs. In comparison, the investment would generate returns to California society—the public sector, participants, and other members of society—of about $11,400 per enrolled child, for a net benefit of more than $7,000 per child (see the middle set of bars in Figure 2). This best estimate projects a return of $2.62 for every dollar invested, or an annual rate of return of about 10 percent if spread over a 60-year horizon.

Our estimates remain sensitive to assumptions about the benefits of current preschool programs and the distribution of benefits among more-advantaged and less-advantaged children. When we considered a range of assumptions, from more to less conservative, the return per dollar invested ranged from about $2 to more than $4. (See the left and right sets of bars in Figure 2.)

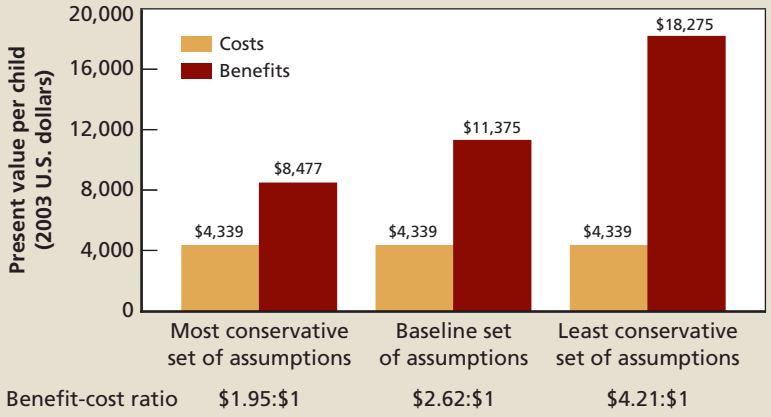
Under our baseline assumptions, the net benefits would be negative for California state and local governments, which we assumed would bear the full costs

**Figure 1—National Preschool Enrollment Rates Are Lowest for Latinos, the Poor, and Those Whose Mothers Have Not Finished High School**




SOURCE: National Center for Education Statistics, *The Condition of Education 2002*, Washington, D.C.: U.S. Government Printing Office, 2002.
NOTE: Estimates are based on children for whom it was reported that they had not yet entered kindergarten. Children from racial/ethnic groups other than white, black, or Latino are included in the totals but are not shown separately. Children without a mother in the home are excluded from tabulations of mothers' education.

**Figure 2—Every $1 California Spends on Universal Preschool Would Yield Roughly $2 to $4 in Benefits to the State**




SOURCE: *The Economics of Investing in Universal Preschool Education in California*, 2005.
NOTE: Dollar amounts are per child in 2003 U.S. dollars for California society as a whole and are the present value of amounts over time. Future values are discounted to age 3 of the participating child, using a 3-percent annual real discount rate.

of the program. However, our projections probably underestimate government savings, because we did not account for reduced use of social welfare benefits and other such savings. Moreover, some would argue that investments in public education programs can be justified as long as the returns to society as a whole are positive, even if the savings to government do not fully cover the program costs.

The social benefits are likely understated as well. We had insufficient data to add some potential benefits, such as the improved health and well-being of children and the reduced pain and suffering borne by victims of child abuse, child neglect, and crime. The best available estimates of the "intangible" costs of these kinds of pain and suffering alone would boost universal preschool's net benefits for California society by nearly 50 percent, from about $7,000 per child to $10,400 per child.

Our analysis does not incorporate some other potential benefits, either. These include near-term benefits for California businesses (in terms of increased labor force recruitment, labor force participation rates, and workforce performance) and longer-term benefits for the state (in terms of increased economic growth, heightened competitiveness, and greater economic and social equality).

A program targeted only at disadvantaged children would be less costly and generate more benefits per dollar expended. However, it would also incur the administrative costs of determining eligibility. It might risk stigmatizing participants. And it would unavoidably miss some children in families who could benefit but would not meet the eligibility criteria or would be confused about the eligibility rules.

Two further lines of reasoning lend support to universal preschool programs:

- If viewed as an economic development strategy (because of its long-term economic benefits), universal preschool compares favorably with other development strategies, including business assistance, workforce education and training, and expansion of local infrastructure. Many of the anticipated returns from such alternatives are illusory; they "generate" jobs that, in reality, would have been created anyway or might simply draw away jobs that would have been created in neighboring communities.
- Public-sector investment in K–12 education has been justified as a critical investment in human capital with long-term benefits. Notably, K–12 education is a universal program. The same argument could be made on behalf of preschool. Public funds would be used to make an investment that would yield a long-term payoff for society, whether in the form of lower government outlays or a higher standard of living.

## Challenges Remain

While the evidence on the potential benefits of broad-scale public preschool is compelling, significant challenges to the implementation of high-quality programs remain. These challenges should not be taken lightly as states move toward expansion. The quality factor is key to achieving policy and outcome goals for such efforts, and until state programs with ambitions of universality can also deliver quality, the benefits that may accrue from them are unlikely to be as significant as hoped.

About half of preschool participants nationwide today are in publicly supported programs. Public preschool is funded through a mixture of federal, state, and local government money, supplemented by private and nonprofit funding. The federal government supports preschool targeted to the disadvantaged, both directly through the Head Start program (which serves about 900,000 children) and indirectly through state-level allocations of other federal funds to preschool efforts. (These other federal funds come primarily from Temporary Assistance for Needy Families and the Child Care Development Fund.) Thirty-six states provide additional support to make preschool available to greater numbers of disadvantaged children.

The movement to expand public provision of preschool has gained momentum in recent years. Georgia and Oklahoma already offer preschool to all 4-year-olds. Other states and localities are in various stages of implementing universal programs.

Because funding for preschool is often scarce, most states combine their resources with funds from Head Start and the other federal programs. But therein lies a central dilemma: The federal and state programs typically stipulate different eligibility and reporting requirements and often operate on different timelines, producing administrative obstacles to a unified effort.

Departments of education, of health and human services, and of economic development are all key players in preschool programs across the states. Programs with these multiple departmental auspices at the funding level may also create bureaucratic confusion or competition at the implementation level and thus undermine strong state efforts to streamline preschool systems. Having multiple

authorities can also result in fragmented or confused data systems used for monitoring and evaluation efforts, which are essential to ensure that investments are justified and quality is maintained.

Cobbling together funding from various sources could also influence content and quality as states struggle to streamline their accountability systems across funding streams. States balancing multiple demands may feel pressure to adopt narrow accountability systems that focus primarily on academic standards. Such accountability systems run the risk of artificially separating cognitive achievement from multidimensional child development, thus imposing an undue emphasis on cognitive growth in program design, implementation, and assessment.

Public awareness needs to be raised about this matter: Many factors beyond cognitive growth are essential for healthy child development and school readiness. These factors include child wellness and nutrition, family and workforce support, and parent education. If preschool focuses merely on cognitive development, other program components that promote broader school readiness skills might be less easily justified in a tight funding environment.

Preschool quality may also be compromised by staffing constraints. At this time, there are not enough high-quality teachers available for expanded preschool programs because of low salaries and limited training opportunities for staff. Training, professional development, and compensation of preschool staff will be core concerns as programs develop.

In most states, making high-quality preschool programs accessible to all children will likely require close and collaborative relationships among public schools, community preschools, and Head Start providers to meet the staffing, facilities, and access needs. Efforts across state bureaucracies responsible for these various providers should be integrated and, if necessary, reorganized to reduce turf wars. In particular, officials should consider whether having school districts dominate preschool efforts might reduce access to the programs, especially among minority families and others who are most in need of the services and who may be more effectively served by other providers.

If the currently limited levels of funding for public preschool remain constant or decline as program eligibility expands, the participation of all eligible families may be constrained. Families who currently do not meet the income guidelines for subsidized program participation might continue to be excluded at the local level if "universal" implementation is provided by states that lack enough classrooms or other resources to offer preschool to all eligible children. Without substantial, sustained funding for all families in all neighborhoods, "universal" preschool could fall short of reaching all the intended children.

**Public awareness needs to be raised about this matter: Many factors beyond cognitive growth are essential for healthy child development and school readiness.**

For policymakers considering investments in early childhood intervention programs, a body of sound research exists from which to guide resource allocations. The evidence sheds light on the types of programs that have been demonstrated to be effective and the potential for returns to society that exceed the investments. These proven results signal the promise of investing early in the lives of children.

The economic benefits of universal preschool also appear favorable, although our results rest on the assumption that high-quality programs could be implemented and sustained on a large scale. Given the implementation concerns we have raised, the transition to publicly financed universal programs would best be accomplished by phasing in their coverage. The place to start would be in low-income communities, where the benefits are likely to be the largest and where access is currently the lowest. From there, the programs could grow to benefit all children within a state, not just those at greatest risk. ■

## Related Reading

*Early Childhood Interventions: Proven Results, Future Promise,* Lynn A. Karoly, M. Rebecca Kilburn, Jill S. Cannon, RAND/MG-341-PNC, 2005, 160 pp., ISBN 0-8330-3836-2, $24 (includes a summary reference card).

*The Economics of Investing in Universal Preschool Education in California,* Lynn A. Karoly, James H. Bigelow, RAND/MG-349-PF, 2005, 236 pp., ISBN 0-8330-3779-X, $28.

*The Economics of Investing in Universal Preschool Education in California: Executive Summary,* Lynn A. Karoly, James H. Bigelow, RAND/MG-349/1-PF, 2005, 13 pp., ISBN 0-8330-3795-1, $15.

*Going to Scale with High-Quality Early Education: Choices and Consequences in Universal Pre-Kindergarten Efforts*, Rachel Christina, JoVictoria Nicholson-Goodman, RAND/TR-237-EDU, 2005, 106 pp., available online only at www.rand.org/publications/TR/TR237.

# A Variety of Early Childhood Interventions Have

ECONOMIC ANALYSES OF EARLY CHILDHOOD INTERVENTIONS have shown that effective programs can repay the investments through government savings, social benefits, and individual benefits. Such favorable economic returns have been demonstrated for programs that use various approaches to early intervention, including those that focus on home visiting or parent education, as well as those that combine home visiting or parent education services with early childhood education.

The programs named in the table at right have been subjected to rigorous benefit-cost analyses. In addition to analyses of individual programs, the table also reports results from two separate benefit-cost analyses based on effects derived from (1) a meta-analysis of multiple home visiting programs serving at-risk children and (2) a meta-analysis of multiple early childhood education programs serving low-income 3- and 4-year-olds.

The results appear in panels based on the age of participants as of the last follow-up: elementary school years, secondary school years, early adulthood, or middle adulthood. One program, the Comprehensive Child Development Program, was not shown to be effective. A second program, the Infant Health and Development Program, showed favorable outcomes as of the last follow-up at age 8, but the outcomes could not be translated into dollar savings.

For the other programs, the estimates of net benefits range from about $1,400 per child to nearly $240,000 per child. The returns to society for each dollar invested range from $1.26 to $17.07.

The largest benefit-cost ratios are associated with programs with longer-term follow-ups (moving further down the table). The later follow-ups allow for the measurement of adulthood outcomes—such as educational attainment, delinquency and crime, and earnings—that translate readily into dollar benefits. The studies with long-term follow-ups show that the benefits from early childhood interventions can be long lasting and that the associated dollar savings can be substantial. If all of the programs followed their participants into middle adulthood, then even larger savings might ultimately be demonstrated for these programs.

Because not all benefits could be translated into dollar values, the benefit-cost estimates are likely to be conservative. The estimates account for declines in the amount of special education provided, decreases in grade repetitions, reductions in youth and adult crime, and increases in workforce productivity among participants. However, the estimates do not account for increases in workforce productivity among the parents of participants or for the potential economy-wide advantages from higher educational attainment among the future workforce. ■

| Program | T |
|---|---|
| **PROGRAM** | |
| Comprehensive Child Development Program | Combination (home combined with early |
| HIPPY (Home Instruction Programs for Preschool Youngsters) USA | Home visiting/parent |
| Infant Health and Development Program | Home visiting/parent |
| **PROGRAM** | |
| Nurse-Family Partnership Program—higher-risk sample | Home visiting/parent |
| Nurse-Family Partnership Program—lower-risk sample | Home visiting/parent |
| Nurse-Family Partnership Program—full sample | Home visiting/parent |
| Home visiting for at-risk mothers and children (meta-analysis) | Home visiting/parent |
| **PR** | |
| Carolina Abecedarian Project | Combination |
| Chicago Child-Parent Centers | Combination |
| High/Scope Perry Preschool Project (including only the "tangible" crime costs of property loss, lost work time, and medical care, for example) | Combination |
| High/Scope Perry Preschool Project (including both the tangible and "intangible" crime costs, such as pain and suffering) | Combination |
| Early childhood education for low-income 3- and 4-year-olds (meta-analysis) | Combination |
| **PRO** | |
| High/Scope Perry Preschool Project | Combination |

SOURCE: *Early Childhood Interventions: Proven Results, Future Promise*, Lynn A. Karoly, M. Rebecca K
NOTES: All dollar values are 2003 U.S. dollars per child and are the net present value of amount

# Generated Favorable Economic Returns

| Type | Age at Last Follow-up | Program Costs Per Child | Total Benefits to Society Per Child | Net Benefits to Society Per Child | Benefit-Cost Ratio |
|---|---|---|---|---|---|
| **S WITH FOLLOW-UP DURING ELEMENTARY SCHOOL YEARS** | | | | | $0 $6 $12 $18 |
| visiting/parent education childhood education) | 5 | $37,388 | –$9 | –$37,397 | — |
| t education | 6 | $1,681 | $3,032 | $1,351 | $1.80:$1 |
| t education | 8 | $49,021 | $0 | –$49,021 | — |
| **S WITH FOLLOW-UP DURING SECONDARY SCHOOL YEARS** | | | | | |
| t education | 15 | $7,271 | $41,419 | $34,148 | $5.70:$1 |
| t education | 15 | $7,271 | $9,151 | $1,880 | $1.26:$1 |
| t education | 15 | $9,118 | $26,298 | $17,180 | $2.88:$1 |
| t education | varies | $4,892 | $10,969 | $6,077 | $2.24:$1 |
| **OGRAMS WITH FOLLOW-UP TO EARLY ADULTHOOD** | | | | | |
| | 21 | $42,871 | $138,635 | $95,764 | $3.23:$1 |
| | 21 | $6,913 | $49,337 | $42,424 | $7.14:$1 |
| | 27 | $14,830 | $76,426 | $61,595 | $5.15:$1 |
| | 27 | $14,830 | $129,622 | $114,792 | $8.74:$1 |
| | varies | $6,681 | $15,742 | $9,061 | $2.36:$1 |
| **OGRAMS WITH FOLLOW-UP TO MIDDLE ADULTHOOD** | | | | | |
| | 40 | $14,830 | $253,154 | $238,324 | $17.07:$1 |

$0 $6 $12 $18

Kilburn, Jill S. Cannon, RAND/MG-341-PNC, 2005, 160 pp., ISBN 0-8330-3836-2, $24.
s over time. Future values are discounted to age 0 of the participating child, using a 3-percent annual discount rate. Numbers may not sum due to rounding.

# In Search of Energy Security

## Will New Sources and Technologies Reduce Our Vulnerability to Major Disruptions?

**By James T. Bartis, Mark A. Bernstein, Tom LaTourrette, and Debra Knopman**

*Jim Bartis and Mark Bernstein are RAND senior policy analysts who specialize in research on energy and the environment. Tom LaTourrette is a RAND physical scientist specializing in science and technology policy. Debra Knopman is vice president and director of RAND Infrastructure, Safety, and Environment.*

Among the critical weaknesses in America's infrastructure laid bare by the spate of Gulf Coast hurricanes of 2005 are the fragility of U.S. offshore domestic oil and gas production facilities and coastal refineries and their vulnerability to disruption. One deceptively simple solution would be to spread the critical energy infrastructure more evenly around the country, preferably to less disaster-prone regions. However, there is much more to the story of U.S. energy insecurity than merely the geographic concentration of infrastructure.

We define *energy insecurity* as a susceptibility to prolonged supply disruptions and price spikes. Part of our susceptibility does stem from the heavy concentration of refined energy products (such as gas, aviation, and maritime fuels) at very few spots in the supply chain (such as New Orleans and Long Beach) that are vulnerable to natural disasters or to a major terrorist event. But the degree of energy insecurity now facing the United States will require a response far more sophisticated than just spreading the problem around. The reality is that neither new energy sources nor new energy technologies can reduce our vulnerabilities in the next 10 to 20 years.

**The reality is that neither new energy sources nor new energy technologies can reduce our vulnerabilities in the next 10 to 20 years.**

In the short term, the strategies that can be deployed the most productively are conservation, improved efficiency, and other demand-side measures. There are physical and economic limits, however, to how far these measures can take us toward a more secure future. Simultaneously, we need to explore new supplies of fossil-fuel resources, push technological advances in production and utilization of these resources, and perhaps reconsider the role that nuclear power could play if its waste and proliferation issues can be satisfactorily resolved. Over the next several decades, we need to pursue a mixture of demand-side and supply-side measures to keep up with the energy requirements of U.S. and world population growth and to reduce the risks inherent in our current, limited energy portfolio.

There is much that the public and private sectors can do to lay the groundwork for improving our energy security in the next 25 to 50 years. Oil shale is a potentially significant new source of fossil fuel, and this particular source of energy faces the common technological hurdles associated with moving from first-of-a-kind plants to major commercial scale-up. There are

economic, environmental, and social hurdles as well. As in many cases of oil and gas exploration, the economic constraints alone could considerably curtail production and distribution. We offer guidelines to help manage these kinds of challenges. We also envision research on energy alternatives, including hydrogen development, as a long-term investment to expand our options.

Diversifying America's energy portfolio would help the nation not just to reduce its energy vulnerability but also to do a better job of protecting the environment. Several emerging energy investment options could serve both energy and environmental needs. Each option merits further study, but the key point is that no single option alone will suffice. Only a larger, balanced package of investments can reduce our energy insecurity in the long run.

## Short-Term Option: Efficiency

Part of the challenge in diversifying our energy portfolio lies in balancing short-term, medium-term, and long-term options, all of which are needed. The best near-term option for increasing our energy security is increasing our energy efficiency. No matter what sources of energy supply we tap or how we tap them, improved efficiency can help us manage energy demand.

As a mandate for greater energy efficiency, the 2001 National Energy Policy released by the Bush administration called for continued reductions in *energy intensity*, which is typically defined as *energy consumption per dollar of gross economic output*. To help identify the most promising ways to reduce energy intensity nationwide, we compared the changes in energy intensity within each of the 48 contiguous states between 1977 and 1999.

We found that state-sponsored energy efficiency programs cost-effectively curbed growth in energy use, alleviated pressure on energy systems, and reduced price volatility. The five states with the greatest overall reductions in energy intensity (after accounting for various economic and natural conditions across the states) were Washington, Oregon, Kansas, Arizona, and North Carolina.

If it were possible for each state to reduce its energy intensity to the same degree as these five states, then the nation's energy use per dollar of economic output could fall by 2020 at a rate twice as fast as that forecast by the federal Energy Information Administration. This finding suggests that there may be ways for the U.S. Department of Energy to help states share valuable information with one another about effective state-level actions to reduce energy intensity.

**The best near-term option for increasing our energy security is increasing our energy efficiency.**

## Medium-Term Option: Oil Shale

The United States contains massive amounts of oil in mineral deposits, known as oil shale, in the border area of Colorado, Utah, and Wyoming. The recoverable energy from these deposits might be more than the equivalent of 800 billion barrels of crude oil—more than triple the known oil reserves of Saudi Arabia. However, many uncertainties remain regarding the development of oil shale in ways that are economically, technologically, environmentally, and socially sound. Substantial development remains a dream that will not become reality for decades, at the earliest.

Oil shale is a sedimentary rock containing petroleum-like solids. The solids are released when the rock is heated—a process called retorting. For about a century, Western oil shale deposits have been touted as an alternative source for conventional crude oil, but production costs have persistently remained above conventional oil prices.

The economics could possibly change in the foreseeable future. As a result of rising world petroleum

*Claudia Delgado, 16, helps assemble an insulated concrete form wall during an Energy Star Technical School Outreach workshop in Worcester, Mass., on Feb. 3, 2005, as Mark Dillon, 17, looks on. Both are students at Upper Cape Cod Regional Technical School. The workshop taught technical high school students about energy-efficient building techniques.*

AP/JULIA MALAKIE

AP/DOUGLAS C. PIZAC

*Oil shale, which is rock containing deposits of oil, burns on its own once lit with a blowtorch.*

prices and advances in extraction techniques, oil shale deposits that are now difficult to extract from the Western United States could be recoverable in the future at costs that would make the deposits a major provider of U.S. energy needs and an economically attractive alternative to conventional crude oil. If the technological, environmental, and governance issues are resolved—a big "if"—oil shale could become the source of millions of barrels per day of competitively priced oil in 20 to 30 years.

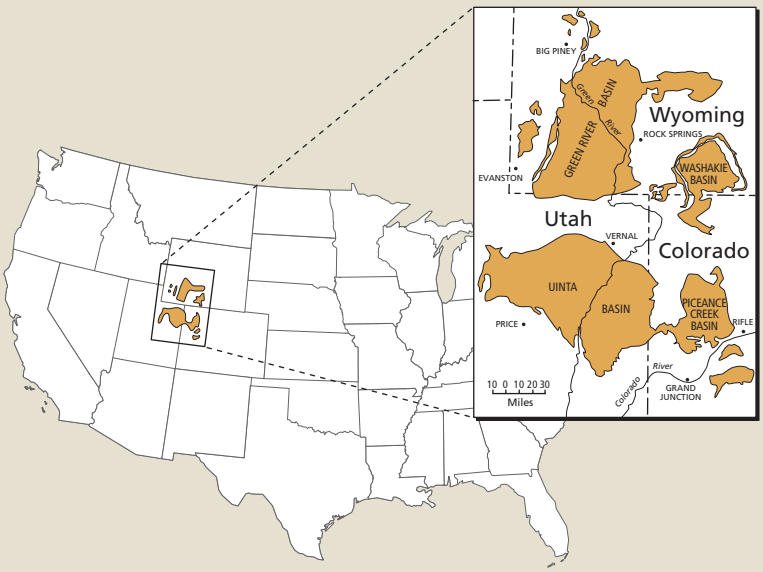
Between 500 billion and 1.1 trillion barrels of oil are technically recoverable from high-grade oil shale deposits located in the Green River geological formation, which covers parts of the three Western states (see figure). The midpoint of our estimate—800 billion barrels—is the amount that is three times the size of Saudi Arabia's known oil reserves. If recoverable, this amount would be enough oil to meet 25 percent of America's current oil demand for the next 400 years.

The benefits of a competitive oil shale industry would be substantial. An output of 3 million barrels per day could generate profits of about $20 billion per year. Federal, state, and local governments would receive about half of this amount in the form of lease payments, royalties, and taxes. Production at this rate would also likely cause oil prices to drop by 3 to 5 percent, saving American oil consumers roughly $15 billion to $20 billion annually. A multimillion-barrel per day oil shale industry could also create several hundred thousand jobs in the United States.

However, the many uncertainties noted above will not be resolved until the initial round of large-scale commercial oil shale facilities are constructed and operated. Given the large uncertainties involved, we recommend that oil shale development proceed at a measured pace to enable evaluation and course correction along the way. As with the development of conventional energy sources in general, oil shale development will likely be subject to various costs and barriers that could become prohibitive and that should therefore be factored into the development equation, as much as possible, sooner rather than later (see sidebar on pp. 24–25).

In strictly economic terms alone, production based on older oil shale mining and processing tech-

**The Main Basins of the Greater Green River Oil Shale Formation Straddle Three Western States**




SOURCE: Adapted from J. W. Smith, "Oil Shale Resources of the United States," *Mineral and Energy Resources*, Vol. 23, No. 6, Colorado School of Mines, 1980.

nologies—such as open-pit surface mining and above-ground retorting—would not likely be profitable unless crude oil prices consistently stay above at least $70 per barrel. The price of crude oil jumped above that threshold in August in response to Hurricane Katrina. But prices have since fallen below that mark.

One emerging technological development involves heating the oil shale while it is still in the ground—a process called in-situ conversion. In this case, mining is not required. Instead, electric heating elements are placed in bore holes, slowly heating the oil deposit. The released liquids are gathered in wells specifically designed for that purpose.

Unlike surface mining, in-situ conversion does not permanently alter the topography and thus may be significantly less damaging to the environment. Small field tests conducted by Shell Oil Company involving an in-situ approach appear promising. While larger-scale tests are needed, Shell anticipates that this method may be competitive with crude oil priced below even $30 per barrel. We have not developed an independent estimate of the price level needed to make in-situ conversion economically competitive.

Some adverse land and ecological impacts will accompany oil shale development no matter which technological approach is used. Production will result in airborne and greenhouse gas emissions that could severely limit production levels. And because the entire Green River formation lies in the Colorado River drainage basin, water quality will remain an important issue. At present, not enough is known about how to prevent water contamination, either from surface mining or from in-situ operations.

Regarding the social impact, even a relatively small development effort, such as the construction of a few initial commercial plants, would stimulate a significant increase in the populations of northwestern Colorado and Uinta County in Utah. Rapid population growth would likely stretch the financial ability of local communities to provide necessary public services and amenities.

More than 80 percent of high-grade oil shale resources lie under federal lands within a concentrated geographic area. Therefore, the key governance issue is the approach that the U.S. Department of the Interior would use to allow access to the federal lands.

Because the resources are so geographically concentrated, federal leasing of the lands would need to balance the development opportunities with the environmental and land-use impacts. Otherwise, early oil shale developers could overstress the environmental carrying capacity of the area, and we would never see more than a few hundred thousand barrels per day of production.

**If the technological, environmental, and governance issues are resolved—a big "if"—oil shale could become the source of millions of barrels per day of competitively priced oil in 20 to 30 years.**

Because the prospects for oil shale remain uncertain, the federal government should refrain from major investments until the private sector is prepared to commit its technical, management, and financial resources. Meanwhile, the federal government should take a few low-cost steps to move development forward. The government should add oil shale to the U.S. Department of Energy's research and development portfolio; establish a national archive of oil shale resources, technologies, and development impacts; and analyze potential lease options, such as combining adjacent tracts and fostering extensive resource recovery from any leased tracts.

When private firms send unambiguous signals of their willingness to invest in development without an appreciable government subsidy, federal decisionmakers should then address the remaining environmental,

AP/ED ANDRIESKI

*A ranch with 70 gas and oil drilling sites is located east of Parachute, Colo. The Roan Plateau, rich in oil shale, is at left. Interstate 70 and the Colorado River are at right.*

AP/DOUGLAS C. PIZAC

*Heaters surround the test well at Shell Oil's project southwest of Meeker, Colo., on July 28, 2005. The company has been working on a way to bake shale oil from the ground by using heating rods drilled into layers of rock.*

social, leasing, and other policy issues. Under these conditions, the U.S. government should (a) sponsor research on options for mitigating ecological damage; (b) conduct research on the subsurface environment and on options for long-term spent shale disposal; (c) create models of regional air quality to determine preferred leasing locations and criteria for development permits; and (d) develop an oil shale leasing strategy for the Green River formation.

Because oil shale development could profoundly affect local residents and other stakeholders in the area, their inputs would need to be sought and valued early in the federal decisionmaking process. The same holds true of the affected state governments, tribal governments, and the wider citizenry, including nongovernmental organizations committed to environmental protection, wildlife conservation, and alternative land uses. For these reasons, the federal government should consider creating a regionally based organization dedicated to planning, oversight and advice, and public participation.

## Long-Term Option: Hydrogen

Hydrogen represents a new type of energy form that could take many decades to harness and to distribute in quantities large enough to improve our energy security on a national scale. One key obstacle is that the nation currently has an elaborate infrastructure in place to distribute fossil fuels, whereas nothing comparable exists for hydrogen.

**Hydrogen development and distribution would require the involvement of many government agencies.**

Hydrogen has drawn attention because of its long-term potential to replace gasoline for use in automobiles. Currently, U.S. transportation is about 95 percent dependent on gasoline. As we have seen during the past year, this heavy dependence on the fuel can lead to soaring gas prices and general price volatility. The only way that consumers today can hedge against the fluctuating prices is to use less gas. For these reasons, hydrogen appeals to some energy experts as a potential alternative source of transportation fuel.

Yet many significant barriers remain. To begin with, hydrogen itself is not an energy source but rather an energy carrier. It must be derived from another energy source, such as electricity or natural gas, thus entailing processes that require significant energy input. There are major uncertainties regarding technology, the cost-effectiveness of hydrogen, its environmental impact, its commercial viability, and the need for a hydrogen distribution system.

An additional concern is that hydrogen development and distribution would require the involvement of many government agencies, from the Federal Energy Regulatory Commission to state public utility commissions to local agencies responsible for building and fire codes, zoning, air pollution control, and public transit. Rationalizing the roles and responsibilities of these various agencies and jurisdictions could be an important factor in determining the future success or failure of a transition from other energy sources to hydrogen.

The lack of consistent, independent government estimates of the costs, benefits, and requirements of hydrogen development has also hindered research and development investment in this potentially critical technology. The Bush administration has made a substantial commitment to fund hydrogen research and development with the clear expectation that the bet will pay off in the form of hydrogen playing a leading role in the nation's long-term energy portfolio.

## A Balanced Set of Options

The examples cited above suggest that a balanced energy investment portfolio must contain a mixture of investment time horizons as well as a mixture of energy resources and strategies. No single time frame, no single resource, and no single development scheme will suffice in producing energy security for the United States. Each option offers advantages and disadvantages.

We at RAND have developed useful planning tools that could help decisionmakers strike the optimum balance among the available options. One such tool is called assumption-based planning; in essence, it is a sophisticated way of comparing multiple scenarios to understand what happens when assumptions prove false and, consequently, plans go awry. Such a tool could help the U.S. Department of Energy modify its research and development portfolio to help reduce the nation's vulnerability to long-term threats to energy supplies.

In general, the greatest reductions in vulnerability come with greater diversity in investments across demand-side and supply-side strategies. Even with increased diversity, the examples described above illustrate just how challenging—and long—the path toward energy security will be. ■

AP/JEFF CHIU

***San Francisco Mayor Gavin Newsom steps off of a hydrogen fuel–cell zero-emission bus at the San Francisco Recycling and Disposal Center as part of the United Nations World Environment Day in San Francisco on June 2, 2005.***

## Related Reading

*Assessing Gas and Oil Resources in the Intermountain West: Review of Methods and Framework for a New Approach*, Tom LaTourrette, Mark Bernstein, Paul Holtberg, Christopher G. Pernin, Ben A. Vollaard, Mark Hanson, Kathryn H. Anderson, Debra S. Knopman, RAND/MR-1553-WFHF, 2002, 98 pp., ISBN 0-8330-3178-3, $20.

*Assessing Natural Gas and Oil Resources: An Example of a New Approach in the Greater Green River Basin*, Tom LaTourrette, Mark Bernstein, Mark Hanson, Christopher Pernin, Debra Knopman, Adrian Overton, RAND/MR-1683-WFHF, 2003, 111 pp., ISBN 0-8330-3360-3, $30.

*Gauging the Prospects of a U.S. Oil Shale Industry*, RAND/RB-9143-NETL, 2005, 2 pp., www.rand.org/publications/RB/RB9143.

*Implications and Policy Options of California's Reliance on Natural Gas*, Mark A. Bernstein, Paul D. Holtberg, David Ortiz, RAND/MR-1605-EF, 2002, 58 pp., ISBN 0-8330-3217-8, $15.

*Long Range Energy R&D: A Methodology for Program Development and Evaluation*, James T. Bartis, RAND/TR-112-NETL, 2004, 65 pp., ISBN 0-8330-3543-6, $20.

*A New Approach to Assessing Gas and Oil Resources in the Intermountain West*, Tom LaTourrette, Mark Bernstein, Paul Holtberg, Chris Pernin, Ben Vollaard, Mark Hanson, Kathryn Anderson, Debra Knopman, RAND/IP-225-WFHF, 2002, 8 pp., www.rand.org/publications/IP/IP225.

*New Forces at Work in Refining: Industry Views of Critical Business and Operations Trends*, D. J. Peterson, Sergej Mahnovski, RAND/MR-1707-NETL, 2003, 145 pp., ISBN 0-8330-3436-7, $24.

*Oil Shale Development in the United States: Prospects and Policy Issues*, James T. Bartis, Tom LaTourrette, Lloyd Dixon, D. J. Peterson, Gary Cecchine, RAND/MG-414-NETL, 2005, 87 pp., ISBN 0-8330-3848-6, $20.

*The Public Benefit of Energy Efficiency to the State of Washington*, Mark Bernstein, Christopher G. Pernin, Sam Loeb, Mark Hanson, RAND/MR-1589-EF, 2002, 84 pp., ISBN 0-8330-3186-4, $20.

*RAND Forum on Hydrogen Technology and Policy: A Conference Report*, Mark A. Bernstein, RAND/CF-218-ISE, 2005, 60 pp., ISBN 0-8330-3817-6, $15.

*State-Level Changes in Energy Intensity and Their National Implications*, Mark Bernstein, Kateryna Fonkych, Sam Loeb, David Loughran, RAND/MR-1616-DOE, 2003, 115 pp., ISBN 0-8330-3416-2, $20.

# Better Resource Assessments Would Improve Resource Development

New energy sources—even new forms of conventional energy sources—take decades to bring to market and are highly sensitive to national and global market conditions. Like all currently used sources, new energy sources also carry environmental costs. Therefore, their contribution to a diversified energy portfolio needs to be appropriately valued to account for the net benefits of development.

In assessing the viability of new supplies of domestic natural gas and oil resources, for example, public land managers would do well to include economic and environmental considerations earlier in the assessment process than would traditionally be the case. By understanding the differences in the economics of production and environmental assets at different locations, public land managers could set priorities for opening lands to development. More gas and oil could be extracted faster, more efficiently, and at less cost to the environment.

AP/SOUTHERN UTAH WILDERNESS ALLIANCE/KEVIN WALKER

*Hatch Point, the rock outcropping at right, is an area proposed for oil and gas drilling on Bureau of Land Management (BLM) land outside Canyonlands National Park in southeastern Utah. The National Park Service filed objections with BLM on Aug. 5, 2005, saying the rigs would spoil the views from the national park, including views of La Sal Mountains in the background.*

**Public land managers would do well to include economic and environmental considerations earlier in the assessment process than would traditionally be the case.**

Conventional assessments of natural gas and oil resources estimate the "technically recoverable" resource, which refers to the amount of a resource that is considered recoverable given certain assumptions about technical capabilities. However, the definition of the term "technically recoverable" is unclear and inconsistently applied among traditional assessments. In all cases, the "technically recoverable" resource fails to represent the amount of a resource that is realistically recoverable, because the assessments of technically recoverable resources disregard political, economic, environmental, and other considerations.

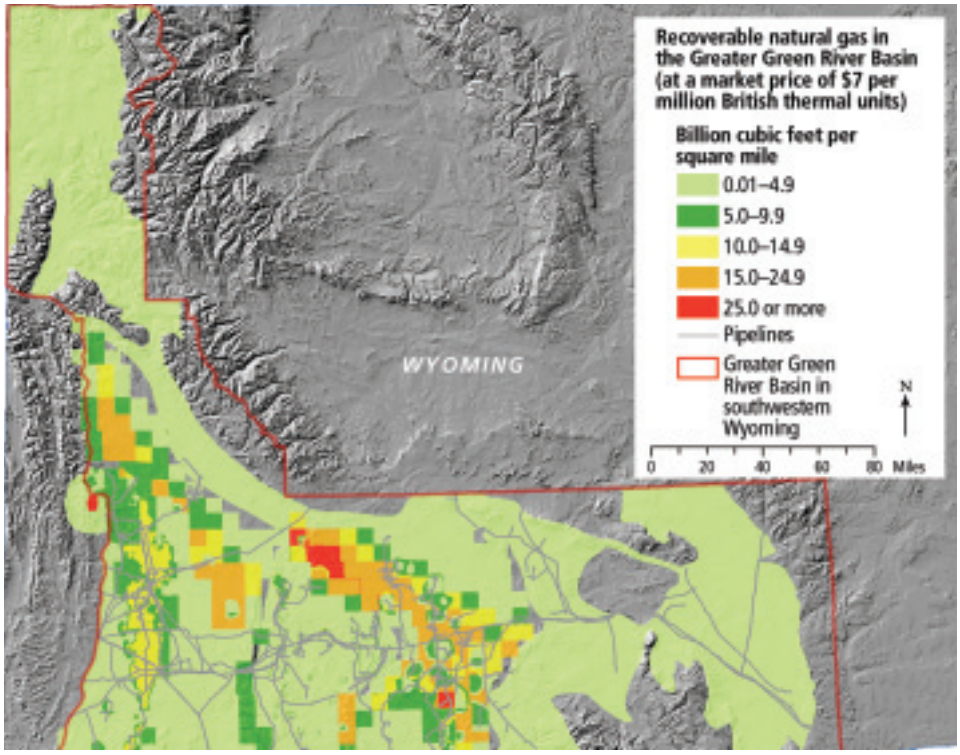
We propose a way of assessing resources that puts more useful information in the hands of decisionmakers. In simple terms, our proposed approach involves overlaying two assessments: the amount of oil and gas available as a function of development cost, and the amount of oil and gas associated with various environmentally valuable resources. Overlaying maps of these assessments can reveal the locations of greatest likely development and least likely harm.

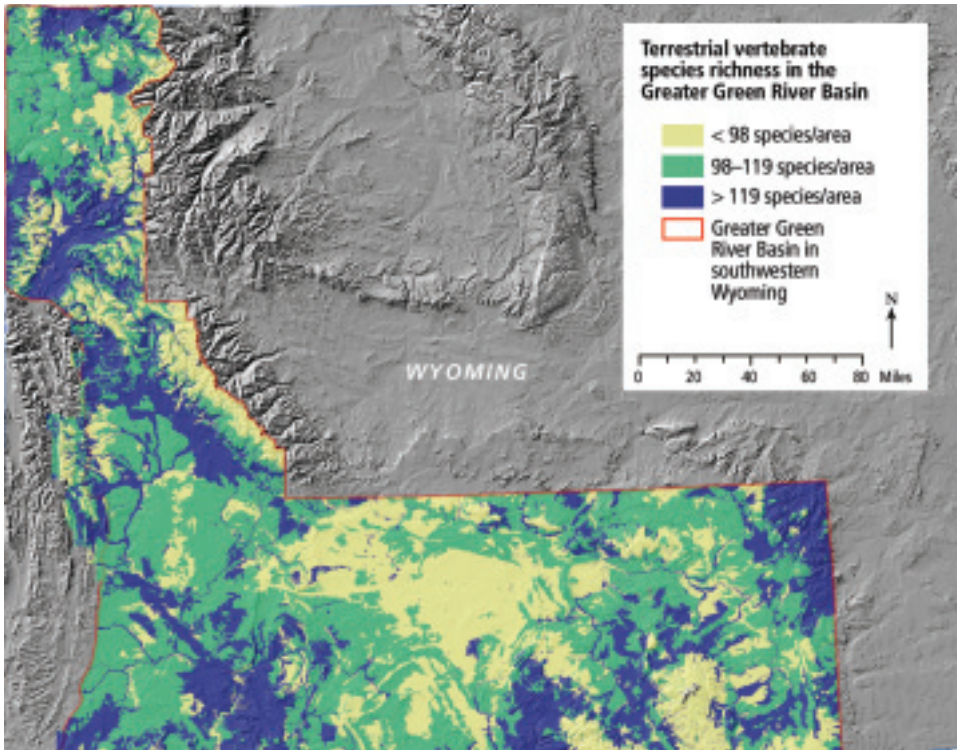
We applied this approach to the Greater Green River Basin, which lies mostly in southwestern Wyoming. The area not only is a potential source of oil shale, as described on previous pages, but is also estimated to contain about 15 percent of the nation's natural gas resources.

As expected, we found that only a subset of the technically recoverable natural gas in the basin is recoverable at current prices. Moreover, some areas with relatively high natural gas concentrations overlap areas with critical environmental characteristics, such as relative proximity to human settlements, relatively shallow groundwater, relatively important riparian habitats, and relatively high quantities of terrestrial vertebrate species (see the two maps at right for an example). These insights would be useful in determining whether or not to develop natural gas from areas that might appear promising based on the economic analysis alone but that might also pose significant environmental consequences.

The information gleaned from this method of assessing resources would be especially useful to public land managers, who could improve the efficiency of the development process by establishing priorities in granting permits for natural gas and oil exploration and production. This information could also help policymakers at many levels of land management develop strategic resource plans, render difficult decisions about access to federal lands, and understand the potential consequences of those decisions. ■

**Some Areas with Relatively High Natural Gas Concentrations Overlap Areas with Critical Environmental Characteristics**




SOURCE: *Assessing Natural Gas and Oil Resources*, 2003.

AP/ED ANDRIESKI

*A pair of young osprey spread their wings in the wind on their nest in Parachute, Colo., on July 19, 2005. As the energy industry studies the possibility of restarting oil shale production in the Rockies, the region is still trying to figure out how the current natural gas boom is affecting wildlife and an economy that relies on tourism and recreation.*

**Only a subset of the technically recoverable natural gas is recoverable at current prices.**

# Bulging Repertoires

## Treatments and Complications for the Overweight and Obese Expand with the Population

By Margaret Maglione, Lisa Shugarman, and Melony Sorbero

*Margaret Maglione, Lisa Shugarman, and Melony Sorbero are public policy and health policy analysts at RAND.*

The growing ranks of overweight and obese individuals in industrialized countries are expanding the market for some types of medical treatments while complicating the administration of others. Pharmaceutical companies and surgeons are offering multiple new treatment options for people who are overweight or obese. Meanwhile, some oncologists are questioning whether they should increase the doses of chemotherapy for overweight or obese women who suffer from breast cancer.

We have studied the effects of three kinds of medical treatments for the overweight and obese. We summarize our findings as follows:

- For overweight or obese individuals, prescription diet drugs promote moderate weight loss when prescribed with diet recommendations. The drugs produce varying minor short-term side effects, such as insomnia and gastrointestinal upset.
- For people who are morbidly obese, bariatric surgery results in greater weight loss than does a combination of prescription medications, diet, and exercise. For those who are less severely overweight, the benefits of bariatric surgery are inconclusive. About 10 to 20 percent of those who undergo bariatric surgery experience complications. Although most complications are minor, some can be serious. The overall death rate from such surgeries is less than 1 percent.
- Overweight and obese women who receive chemotherapy for breast cancer are often undertreated. Some doctors apparently either base the chemotherapeutic doses for these women on their ideal weight or cap the doses at a threshold because of unfounded concerns about the potential for toxic side effects if the doses are increased to account for body weight. The poorer prognosis for survival among obese women may therefore be the result of inadequate doses of chemotherapy.

Individuals are deemed overweight if their body mass index (BMI, a ratio of weight in kilograms divided by height in meters squared) rises to between 25 and 29.9. Individuals whose BMI reaches 30 or higher are considered obese, while those with a BMI of 40 or above are considered morbidly obese. For example, a person who is 5 feet 10 inches tall and weighs 209 pounds has a BMI of 30, while a person who is 5 feet 10 inches tall and weighs 280 pounds has a BMI of 40.

An estimated 30 percent of the U.S. population is obese, and many industrialized countries have seen similar prevalence rates. The health consequences of obesity are considerable. Yet weight loss of 5 to 10 percent of total weight could markedly reduce the risks of chronic obesity-related diseases, including heart disease, diabetes, osteoarthritis, hypertension, breast cancer, and other forms of cancer.

### Modest Results from Diet Drugs

About 40 percent of Americans are trying to lose weight, accounting for the increased number and popularity of prescription weight-loss medications. To assess their effectiveness and safety, the Southern California Evidence-Based Practice Center, based at

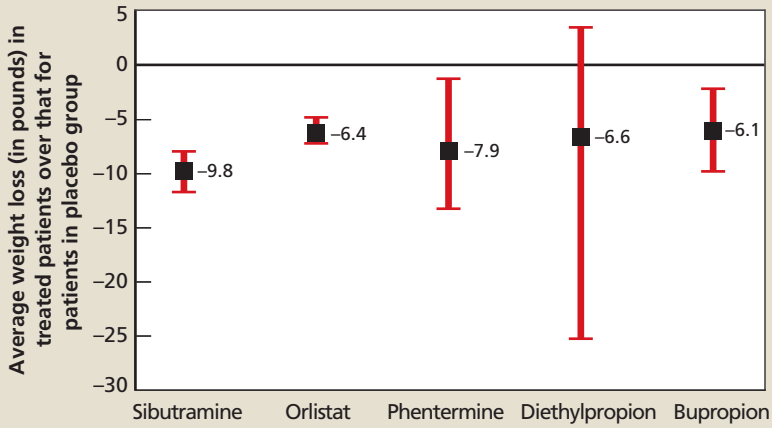
RAND, analyzed 79 published studies of clinical trials of the most popular diet drugs.

Among prescription medications approved by the U.S. Food and Drug Administration (FDA) for weight loss, all but one are appetite suppressants. The exception is orlistat, which inhibits the digestion and intestinal absorption of some dietary fats. We studied four FDA-approved weight-loss medications (sibutramine, orlistat, phentermine, and diethylpropion) and five medications not approved by the FDA specifically for weight loss but that have been tested for this purpose (topiramate, zonisamide, and the antidepressants bupropion, sertraline, and fluoxetine).

Among these medications, the two that have been studied most are sibutramine and orlistat. We found that 12 months of treatment with either drug, compared with a placebo, promoted modest weight loss when diet recommendations accompanied the prescriptions. On average, patients using sibutramine lost 9.8 pounds more than patients in a placebo group, while those using orlistat lost 6.4 pounds more (see Figure 1). Total weight loss for orlistat users averaged 17.9 pounds.

Most of the other medications—phentermine, bupropion, topiramate, zonisamide, and probably diethylpropion and fluoxetine—also promoted moderate weight loss when prescribed with diet recommendations. However, we found no statistically significant difference between patients treated with sertraline versus those who received a placebo.

**Figure 1—Most Diet Drugs Studied Promote Modest Weight Loss When Prescribed with Diet Recommendations**




SOURCE: "Meta-Analysis: Pharmacologic Treatment of Obesity," 2005.
NOTE: Black squares show average weight change. Red bands show 95-percent confidence intervals (we are 95 percent confident that the true average weight change falls somewhere between these banded extremes).

**Most of the medications promoted moderate weight loss when prescribed with diet recommendations.**

Each drug produced short-term side effects, which varied by drug. Side effects ranged from restlessness and elevated heart rate to diarrhea, flatulence, bloating, abdominal pain, and indigestion. Too few of the 79 studies included children or adolescents to allow conclusions to be drawn about the effectiveness or safety of the medications for these age groups.

Just one of the 79 studies assessed long-term outcomes. In a study of 3,000 obese patients who had taken either orlistat or a placebo for four years, weight loss was greater among those taking orlistat. Likewise, the incidence of new diabetes cases was 37 percent lower among the orlistat-treated group. This study supports the hypothesis that long-term treatment with orlistat can reduce weight and help prevent obesity-related health problems. In other studies, weight loss has also been associated with reductions in high blood pressure, blood sugar, and cholesterol levels.

## Surgery Suits Some Better

The growing prevalence of obesity has fueled interest in various surgical procedures, collectively known as bariatric surgery, to induce weight loss. We examined the effectiveness and risks of bariatric surgeries by analyzing nearly 150 published studies of the most commonly performed procedures.

The most common procedure, accounting for about 65 percent of bariatric surgeries performed worldwide, is gastric bypass surgery. This operation involves stapling the upper stomach into a small pouch and creating an outlet to the downstream small intestine, thereby limiting stomach capacity, shortening intestinal length, and cutting the calories and nutrients the body can absorb.

A second common method, particularly outside the United States, is adjustable gastric band-

**Among the morbidly obese, surgery resulted in a loss of 45 to 65 pounds that was maintained up to ten years and was accompanied by significant improvements in several obesity-related conditions.**

ing. In this operation, surgeons tie a restrictive band around the uppermost portion of the stomach and insert a small outlet to the lower stomach. The band can be adjusted for tailoring of the stomach outlet, which controls meal capacity and the rate of the stomach emptying into the intestines. This method accounts for about 24 percent of bariatric surgeries performed worldwide.

Two other surgical techniques were examined in our review. In vertical banded gastroplasty, surgeons staple a hole into the center of the stomach until it resembles a doughnut, thereby shrinking the stomach capacity and restricting food consumption. In biliopancreatic bypass, surgeons create a common channel where contents from the stomach and intestine mix, inducing weight loss primarily through malabsorption.

For morbidly obese individuals—those with an average BMI of 40 or more—bariatric surgery resulted in greater weight loss than did nonsurgical treatments, including prescription drugs and diet recommendations. Among the morbidly obese, surgery resulted in a loss of 45 to 65 pounds that was maintained up to ten years and was accompanied by significant improvements in several obesity-related conditions, such as hypertension, diabetes, elevated cholesterol, and sleep apnea.

The data strongly support the superiority of surgical therapy also for those with BMIs between 35 and 39.9. However, this evidence cannot be considered conclusive in the absence of a study with a concurrent comparison group.

Long-term comparisons of outcomes among the surgeries are available up to only three years after surgery. At the end of this shorter time frame, patients who had undergone gastric bypass surgery lost an average of 91 pounds, compared with 77 pounds for adjustable gastric banding, 71 pounds for vertical banded gastroplasty, and 117 pounds for biliopancreatic diversion (see Figure 2).

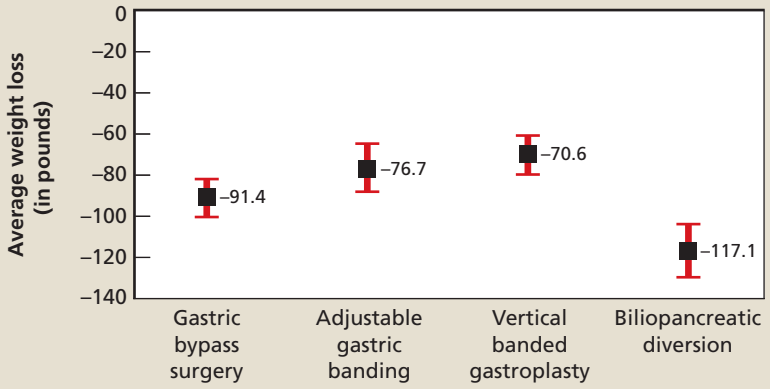
Mortality rates from the surgeries were less than 1 percent, and we found no statistically significant difference in mortality rates among the procedures. Complications from surgery were common but mostly minor in severity, although the occurrence of complications may differ among procedures in clinically important ways (see Figure 3). Too few children and adolescents underwent the surgeries to allow us to assess the effectiveness or safety for these age groups.

## Breast Cancer Undertreated

Obesity both increases the risk for breast cancer and worsens its prognosis. Both the increased risk and poorer prognosis have been attributed to physiological factors, such as higher blood levels of the hormone estrogen. However, an additional factor contributing to the poorer prognosis for obese women, in terms of cancer recurrence and overall survival, might be the delivery of inadequate doses of chemotherapy.

The dosage of most chemotherapeutic drugs is based on the patient's body surface area (BSA), calculated from weight and height and expressed in square meters. Because concerns have been raised about the potential for toxic side effects if chemotherapeutic doses for obese women are increased to account for body weight, some doctors have apparently either

**Figure 2—Patients Who Underwent Bariatric Surgeries Maintained Significant Weight Loss After Three Years**




SOURCE: "Meta-Analysis: Surgical Treatment of Obesity," 2005.
NOTE: Black squares show average weight loss from four types of bariatric surgeries three years following surgery. Red bands show 95-percent confidence intervals (we are 95 percent confident that the true average weight loss falls somewhere between these banded extremes).

based the doses for obese women on their ideal weight or capped the doses at a particular BSA, such as two square meters, even though little evidence exists to support doing so.

In partnership with clinical researchers at the University of Rochester, we used the medical files of nearly 10,000 women treated for non-metastatic breast cancer in the United States between 1990 and 2001 to assess whether obese women were in fact systematically undertreated. We found that overweight and obese women indeed received intentionally reduced doses of chemotherapy for breast cancer more often than did women of healthy weight.

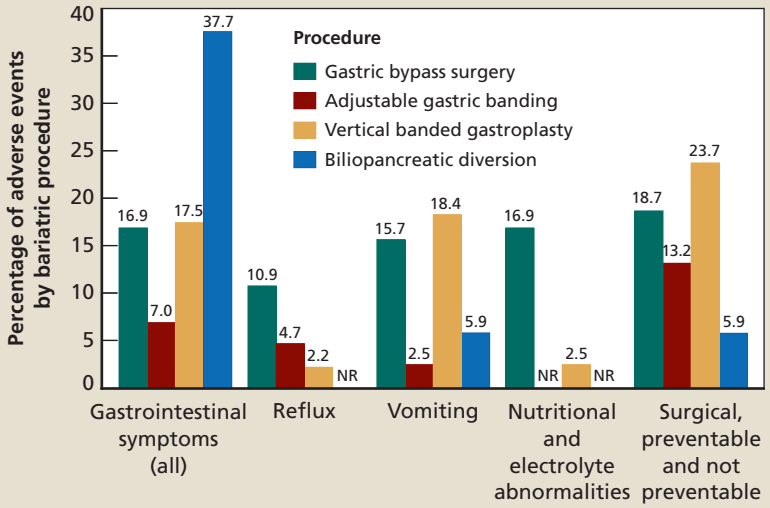
During the first cycle of chemotherapy, doctors reduced the doses by 10 percent or more for fully 37 percent of severely obese women (those with BMIs of 35 or higher), 20 percent of obese women, 11 percent of overweight women, and 9 percent of women of healthy weight (see Figure 4). The average reduction in dosage across all BMI categories was 20 percent.

Increased doses for subsequent cycles of chemotherapy were uncommon. Only 3 percent of overweight and obese women who had initially received a reduced dose received an increased second dose. Just 4 percent of underweight and healthy-weight women received dose escalations.

The irony is that severely obese women, regardless of having received either full or reduced doses, suffered *fewer* severe side effects than did other women. There is accumulating evidence that obese patients do not experience increased toxic effects when dosed according to actual body weight. While not studied specifically in obese women, the receipt of full doses of chemotherapy is associated with improved overall and disease-free survival. There is even the possibility that using actual body weight in dosing the severely obese with breast cancer may still constitute undertreatment.

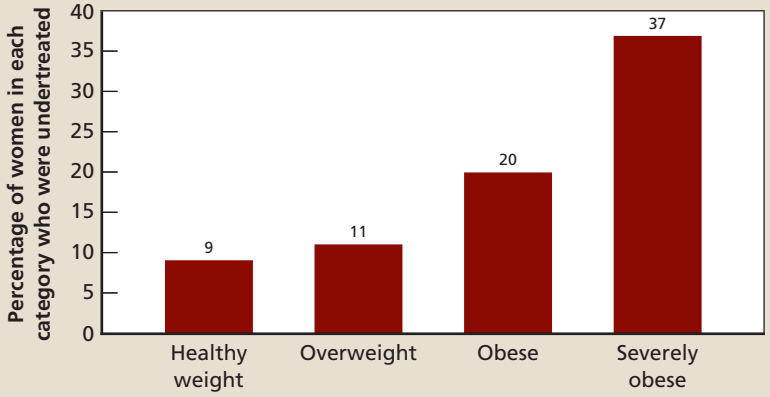
Patients treated in more recent years were less likely to receive dose reductions, but great variability remained in the frequency of dose reductions across the 901 oncology practices studied. This unwarranted variation most likely reflects persistent clinical uncertainty regarding optimal doses for overweight and obese women. As the incidence of obesity, particularly severe obesity, grows in many countries, eliminating unwarranted dose reductions will grow in importance. ■

**Figure 3—About 10 to 20 Percent of Those Who Undergo Bariatric Surgery Experience Complications, Mostly Minor**




SOURCE: "Meta-Analysis: Surgical Treatment of Obesity," 2005.
NOTE: NR = not reported.

**Figure 4—The More Severely Overweight the Women, the Greater the Frequency of Undertreatment for Breast Cancer**




SOURCE: "Undertreatment of Obese Women Receiving Breast Cancer Chemotherapy," 2005.
NOTE: Individuals whose body mass index (BMI) falls between 25 and 29.9 are considered overweight. Obesity is defined as a BMI of 30 or more. Severe obesity is defined as a BMI of 35 or more.

## Related Reading


"Meta-Analysis: Pharmacologic Treatment of Obesity," *Annals of Internal Medicine*, Vol. 142, No. 7, April 5, 2005, pp. 532–546, Zhaoping Li, Margaret Maglione, Wenli Tu, Walter Mojica, David Arterburn, Lisa R. Shugarman, Lara Hilton, Marika Suttorp, Vanessa Solomon, Paul G. Shekelle, Sally C. Morton.

"Meta-Analysis: Surgical Treatment of Obesity," *Annals of Internal Medicine*, Vol. 142, No. 7, April 5, 2005, pp. 547–559, Melinda A. Maggard, Lisa R. Shugarman, Marika Suttorp, Margaret Maglione, Harvey J. Sugarman, Edward H. Livingston, Ninh T. Nguyen, Zhaoping Li, Walter A. Mojica, Lara Hilton, Shannon Rhodes, Sally C. Morton, Paul G. Shekelle.

"Undertreatment of Obese Women Receiving Breast Cancer Chemotherapy," *Archives of Internal Medicine*, Vol. 165, No. 11, June 13, 2005, pp. 1267–1273, Jennifer J. Griggs, Melony E. S. Sorbero, Gary H. Lyman.

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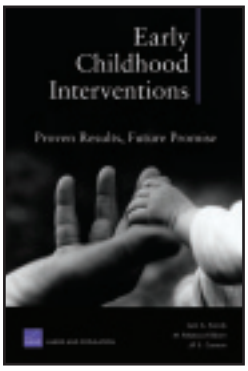

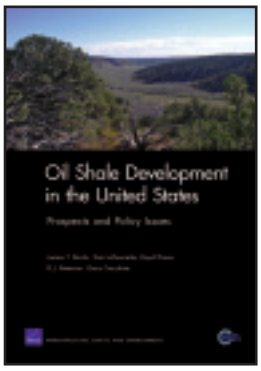

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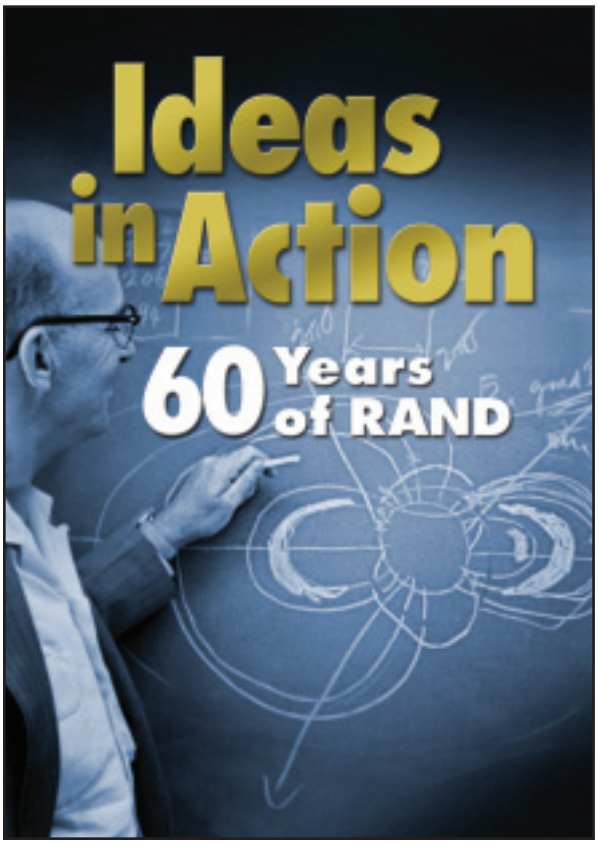


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