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PART 6

Public Health Policies

Environmental and health issues overlap in several regards. For many environmental hazards, the most serious causes of concern are risks to human health. And some key policy design issues are common to both environmental and health problems. These include how to value public health risks and to what extent these risks are internal (that is, taken into account by individuals) versus external (borne by society at large), as this determines the appropriate level of policy intervention.

Two of the commentaries in this section focus on issues in the valuation of human health: one explains why people's valuation of life expectancy (how much they would theoretically pay to live longer) has been steadily rising over time, with important implications for public policies, such as medical research, that potentially yield future improvements in longevity. Another discusses how people in different countries might value changes in mortality risks, a critical issue when evaluating policies with health benefits in those countries.

Specific public health problems are covered, including a brief history of attempts to roll back malaria, the growing threat of superbug infections that are resistant to drugs, the costs and benefits of interventions to reduce tuberculosis, modernizing the regulatory system governing the safety of the U.S. food supply, to what extent health risks warrant taxing cigarettes, and private-sector incentives to market products that help people quit smoking.

Public health programs regarding environmental problems are also evaluated: public information programs to warn about mercury contamination in fish, issues in measuring the human health benefits of reducing exposure to lead, and improving health in low-income countries through use of less polluting cooking methods.

83. THE VALUE OF HEALTH AND LONGEVITY

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The value of increased life expectancy, and health improvements more generally, has been rising over time. This trend has important policy implications, such as the amount we should be investing in medical research.

During the 20th century, life expectancy at birth for an average American increased by roughly 30 years, a remarkable increase that reflects advances against a variety of afflictions and diseases. Progress during the first half of the century was rapid and concentrated at younger ages because of reductions in infant and child mortality. Progress then shifted toward older individuals, with better prevention and treatment for heart disease, strokes, and other older-age ailments. The largest single contributor since 1950 has been reduced mortality from heart disease, which has added more than 3.5 years to the expected lifetimes of both men and women.

Rising life expectancy, and health improvements more generally, represent an important form of economic progress, and their valuation is critical for two reasons. First, traditional measures of economic growth and economic welfare, based on national income accounts, do not take into account this source of rising living standards and may therefore seriously understate improvements in well-being. Second, large portions of both medical research and medical care are publicly funded, and efficient decisions concerning the allocation of these resources require a framework for measuring the benefit of treatment and research-based medical progress.

WHY DO THE VALUE OF HEALTH IMPROVEMENTS RISE OVER TIME?

In a recent study, we developed an economic framework for understanding what factors determine how much people are willing to pay for health improvements that increase both longevity (which increases consumption of goods and leisure time over the life cycle) and quality of life (which raises the utility individuals obtain from given amounts of goods and leisure time). Some health advances (such as better surgical techniques) primarily increase longevity, others (like reduced pain from arthritis) primarily improve the quality of life, and many others (like medications that reduce blood pressure or retard the advance of cancer) improve both aspects of health.

The social value of health improvements has been increasing over the past several decades, and will increase into the future, for a number of reasons, including some simple math. The U.S. population is growing, so proportionately more people benefit from a given advance. As income grows over time, and living standards rise, people gain more enjoyment out of an additional (healthy) year of life. Furthermore, people's willingness to pay for health improvements peaks as they approach the age when they are most vulnerable to the risks of heart disease, cancer, and so on—so the aging of the baby-boom generation has raised the social value of medical advances against age-related ailments.

But most importantly, there is an increasing return inherent to medical progress: past success raises the value of new health improvements. Increases in life expectancy (from any source) raise people's willingness to pay for further health improvements. That is, people are willing to pay more for good health as the likelihood that they will be around to enjoy that health increases. This means that advances against, say, heart disease raise the value of progress against other age-related ailments, such as cancer and Alzheimer's.

ECONOMIC BENEFITS FROM IMPROVED HEALTH

In fact, the economic gains from declining mortality in the United States have been enormous. Cumulative gains in life expectancy during the 20th century were worth nearly \$2 million for a newborn in 2000, or more than \$1.2 million to the average-age American alive in that year. Increased life expectancy between 1970 and 2000 alone added about \$3.2 trillion per year to national wealth—an uncounted value equal to about 50 percent of average annual GDP over the period. About half of this gain since 1970 was from reduced prevalence of heart disease.

Moreover, reductions in mortality since 1970 have raised the value of future health advances by almost 20 percent. Prospective gains from a 10 percent reduction in all causes of mortality in the future would have an enormous social value of almost 20 trillion dollars in present value to current and future Americans. About 30 percent of this is due to potential progress against cardiovascular diseases, and 25 percent from progress against cancer. A 10 percent reduction in mortality from infectious diseases (of which mortality from AIDS accounts for about a third) has a far lower value (about \$500 billion) because of the much lower incidence of this type of disease. For women, mortality-reducing progress against heart disease would be four times more valuable than equivalent progress against breast cancer.

These estimates are conservative in the sense that they focus only on the United States and do not include the value of these same health innovations to the rest of the world. They also ignore corresponding improvements in the quality of life, which, evidence suggests, may be even more valuable than gains in longevity.

WEIGHING COSTS AND BENEFITS

Health improvements are worthwhile if their economic value offsets their additional economic costs. Some of these costs

take the form of changes in consumption or behavior, such as reductions in smoking, increased exercise, healthier eating habits, and moderate alcohol consumption. Other costs are those associated with implementing new procedures and treatments, or extended provision of existing medical service.

Nonetheless, we estimated that additional medical expenditures offset only 36 percent of the value of increased longevity after 1970. Even though the United States now spends more than \$50 billion a year in medical research, about 40 percent of which is federally funded, substantially greater expenditures might be worthwhile given that the returns to basic medical research may be quite large. For example, using our estimate that a 1 percent reduction in cancer mortality would be worth about \$500 billion, then spending an additional \$100 billion on cancer research and treatment would be worthwhile if it has a one-in-five chance of reducing mortality by 1 percent.

One significant caveat is that the presence of third-party payers (insurance companies and the government) increases incentives to spend on medical care, since at the margin the individual receiving treatment bears only a small fraction of the treatment costs. In fact, over 25 percent of all Medicare expenditures are incurred in the last year of individuals' lives, with allegedly little benefit. These pricing distortions may also skew investment in research away from cost-saving improvements in medical technologies. As a result, not all health improvements may be socially efficient.

Further Reading

Murphy, K.M., and R.H. Topel. 2006. The Value of Health and Longevity. *Journal of Political Economy* 114(4): 871–904.

84. HOW U.S. AND CHINESE CITIZENS FEEL ABOUT REDUCING MORTALITY RISKS

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How might a monetary value be attached to reductions in mortality risks from pollution control or other public health policies in low-income countries? This is critical for helping sort out which policies do and do not make sense from a cost–benefit perspective.

To help prioritize policies and to design better regulations, cost–benefit analyses are commonly performed in developed countries and increasingly in developing ones. When it comes to environmental priorities and policies, health effects, especially mortality risks, are often involved. For example, reducing fine particulates, a form of air pollution, has been shown to have a significant effect on reducing death rates from lung cancer and other diseases. To compare the benefits and costs of various policies, however, it is not enough to know about the mortality risks. They must be “monetized,” that is, converted into monetary units, so they can be compared to costs. Indeed, how strongly the public feels about reducing their mortality risks, relative to doing all the other things we can do with our money or expect our government to do, is important, even if one were not doing cost–benefit analyses of regulatory programs.

These preferences are summarized in the term “value of statistical life” (VSL), which simply is the average amount that people are willing to pay to reduce their risks of death by a tiny amount, divided by the amount of this risk reduction. If 10,000 people are willing to pay \$100 on average to reduce their risks of death by 1 in 10,000 (thereby expecting that one less among them will die prematurely), this translates into a VSL of \$1 million ($\$100/[1/10,000]$). Such a number can then be multiplied by the number of premature deaths expected to be cut by, say, a fine particulate policy, to arrive at the mortality benefits of reducing this pollutant.

Note what this number is not. It is not the amount you would pay to save your grandmother’s life, nor the life of any known person. It is not a jury award that the family of a person killed in a wrongful death suit would receive. It is about using a money metric to measure how strongly people feel about reducing their risks of death by a small amount—something they do every time they push their foot down on the accelerator to get to a meeting faster, or cross in the middle of the street to save time. These time–risk trade–offs are easily converted to money terms. Indeed, some people commonly take more risky jobs, like washing windows on skyscrapers in return for a wage boost over what they could get exercising the same skills on the ground.

To date, most VSL estimates have been made in developed countries. But people’s feelings about avoiding death risks are universal—although the strength of this feeling, as expressed in money will depend on many things, some of which may vary systematically across developed and developing countries. For example, wealthier people, other things held equal, are found to be willing to pay more for reducing death risks. Older and ill people may be willing to pay more or less than younger and healthy people—although how much, and even in what direction, are open questions. This difference is important because developing countries typically have a much greater proportion of younger and sicker people than developed countries. The types of risks can matter too: how large they are, what type (is it something you have control over or a risk that’s unfamiliar?) and when they kick in (now or in the future).

Arguably, it is even more important to do good cost–benefit analyses in developing than developed countries because the former have such a shortage of capital and

resources to devote to improving the quality of life.

There are two ways to get estimates of the VSLs. One is to actually do the studies. Here there are two credible approaches—asking people, using highly structured surveys, about their willingness to pay (that is, their “stated” preference) or examining their “revealed” preferences in labor markets (in terms of jobs chosen) and similar places where trade-offs between money and death risk may be observed. The other option is to transfer estimates of the VSL from developed to developing countries, which is the standard practice because it is so cheap to do although not without costs in terms of being inaccurate.

My colleagues and I recently carried out a revealing study in Shanghai and other cities in China, using methods and a survey nearly identical to those used in the United States, Canada, Great Britain, Japan, Italy, and France to value reductions in mortality risk. Our findings showed that in spite of the lower per capita incomes in China, the VSL was not as low as one would expect—about \$700,000 (when adjusting the yuan for purchasing power parity). Further, for future risk reductions, such as one would get from reducing exposure to a carcinogen today, the VSL dropped less in China than in other countries. An inference: the Chinese people may be much more future-oriented than their counterparts in the other countries we tested (certainly savings rates are higher). At the same time, there were commonalities. Older people (over 70) are consistently shown in these surveys to be willing to pay somewhat less than younger people (40–70), although these differences are not always statistically significant. Ill people are also shown to be willing to pay more or the same, but never less than healthy people. And incomes matter within the countries; that is, richer people within a country are willing to pay more to reduce a given risk of death than poorer people in that country. However, in the case of our China

study, cultural factors, possibly optimism about the future or a great fear of death, may act to push up willingness to pay even in less prosperous areas.

At the end of the day, these kinds of studies reveal more to us than simply how the VSL varies; they show how cultural differences translate into preferences for improving health and thereby result in a better allocation of our scarce resources. For example, the China results have already been applied to a major World Bank study assessing the health damages of air pollution. The study’s key finding is that high particulate levels (China has 20 cities in the top 30 most polluted cities in the world) cause mortality damages equal to about 3 percent of GDP. In India, which accounts for 30 percent of the global burden of tuberculosis, the costs of interventions per death prevented are as cheap as \$1,000, cluster around \$10,000, and are as high as \$1 million. With a VSL of, say, \$1 million, all or most of these mortality risk reduction measures would deliver net benefits to society.

Further Reading

- Alberini, Anna, Maureen Cropper, Alan Krupnick, and Nathalie Simon. Forthcoming. Does the Value of Statistical Life Vary with Age and Health Status? Evidence from the U.S. and Canada. *Journal of Environmental Economics and Management*.
- China SEPA and the World Bank. 2007. *Cost of Pollution in China: Economic Estimates of Physical Damages*. Washington, DC: World Bank.
- Krupnick, A., S. Hoffmann, B. Larsen, X-Z. Peng, G.-C. Cheng, et al. 2007. The Willingness to Pay for Mortality Risk Reductions in Shanghai and Chongqing, China. In *Costs of Pollution in China: Economic Estimates of Physical Damages*. Washington, DC: World Bank.
- Symposium on Mortality Risk Valuation and Age. 2007. *Review of Environmental Economics and Policy* 1(2): 228–282.

85. A NEW CHAPTER IN THE HISTORY OF MALARIA CONTROL

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This brief history of attempts to control malaria is especially timely, given the development of effective new drugs to treat the disease and the current attempts by the Gates Foundation and the global community to eradicate it.

Malaria claims the lives of more than a million victims each year, 80 percent of whom are children from sub-Saharan Africa. Causing fever, anemia, malaise, and death in its most severe forms, its greatest impact is on children who have not yet built up the immunity required to combat severe malaria infections. Compounding the devastation wrought by the disease itself, malaria is often blamed for fevers caused by other infections. By interfering with proper treatment of nonmalarial diseases, it contributes to higher death rates from other causes. Furthermore, it reduces economic growth in some African countries by more than 1 percent, costing over \$1,000 a year in per capita GDP. These staggering numbers are finally seeing the light of day.

For the first time in nearly 30 years, new donor money is available to build malaria-control programs. In October 2007, Melinda Gates officially announced the Gates Foundation (WHO), the Global Fund, and the President's Malaria Initiative echoed the message in a surprising show of hope and unanimity about the scientific and donor communities' current capacity to eradicate malaria. The ensuing discussion broke a taboo in the malaria community—born of previous failures to eradicate the disease—and the “e-word” was again spoken openly.

The world's first attempt to eradicate malaria came after World War II. Enthusiasm was stoked by two new tools for malaria control: dichloro-diphenyl-trichloroethane (DDT) and chloroquine. Control trials in the 1950s demonstrated that DDT was very effective at lowering malaria transmission. Soon the chemical was sprayed on the interior walls of houses all over the world. Its odor repelled some mosquitoes, and the residual DDT on the walls killed those mosquitoes that landed to rest after feeding on humans. The combination of effects worked quite well: in many areas where DDT was used, malaria transmission was severely disrupted, with 80 percent annual declines in the prevalence of infection. At about the same time, mass production of the antimalarial drug chloroquine provided a cheap and effective way of treating clinical malaria and curing infections.

To control malaria successfully and ultimately eliminate it, the key epidemiological concept to focus on is malaria's “basic reproductive number,” which measures the expected number of infectious mosquitoes that would be generated by a single infectious mosquito. This number describes the amplification of the infection process and provides a measure of the control effort required to eliminate malaria. Estimates of the basic reproductive number for malaria suggest that it may be as high as 10,000 in some African populations. This means that 99.99 percent of all transmission must be prevented in these areas to eliminate malaria. While drug use is critical for treating clinical malaria, it is not an effective way to reduce transmission. Initial elimination efforts in high-transmission areas met with mixed success, while efforts in low-transmission areas were more successful at ridding these regions of malaria.

By 1970, 24 countries had completely eliminated malaria, but there were equally many places where the effort had failed. Many of these countries were in Africa, where early malaria-control programs substantially reduced malaria transmission but were not enough to eliminate the parasite completely. Early trials in East Africa reduced the fraction of infected people from more than 60 percent to less than 10 percent, but did

not sufficiently interrupt transmission. In the 1970s, WHO organized a massive demonstration project in Garki, Nigeria, to eliminate malaria, but when it failed, it seemed to be the nail in the coffin for global eradication efforts. Donor fatigue, DDT-resistant mosquitoes, and emerging environmental concerns about the overuse of DDT all contributed to the cessation of malaria-control programs in the 1970s. In regions where malaria had been eliminated completely (southern Europe and the southeastern United States), it remained absent. But in areas like India and Sri Lanka, where malaria was not entirely eliminated, the disease came back and reestablished itself at its previous levels.

In the decades that followed, malaria became a neglected disease. To make matters worse, chloroquine-resistant parasites were imported into East Africa in 1978, and the subsequent spread of chloroquine resistance undermined treatment of malaria. Throughout the 1980s and 1990s, malaria mortality increased, even as other causes of mortality declined. Finally, within the past few years, rising malaria mortality has been slowed down by the mass distribution of insecticide-treated mosquito nets, and by switching from chloroquine to other, more effective drugs, most notably a new class of antimalarial drugs called artemisinins. For the current generation of research scientists and public health officials working in malaria control, the recent progress and the new flow of money have been a huge relief, and there is some evidence that control programs have begun to reverse malaria mortality in Africa.

Current research efforts at Resources for Future are focusing on methods of drug distribution, preserving the life span of artemisinin-based combination therapies, finding ways to reverse trends of increasing drug resistance, determining whether subsidies for certain drugs will allow more types of drugs to be used, and understanding if having more types of drugs in use will be beneficial to malaria-control programs. The initial answers to these questions are coming out

of mathematical models that allow us to evaluate hypothetical situations of how malaria might be eliminated in a particular country or region, and how effectively particular treatment strategies or drug subsidies would work in these places.

The worldwide community of malaria researchers is optimistic about the current treatment possibilities and eradication strategies, but enthusiasm for malaria eradication must be tempered with a serious assessment of realistic costs and timelines. The actions necessary to eliminate malaria ultimately will be carried out by individual governments that must rise to the challenges. Even the best efforts can be undermined if a country continually reimports the disease from neighboring countries; if the necessary drugs, bed nets, and insecticides cannot be secured for economic reasons; and if the elimination programs put in place are not sustainable. The coming global effort to eradicate malaria will derive its success from sustainability, coordination, a generous flow of money, and the diligence and will of scientists, doctors, public health workers, and government officials who recognize malaria eradication as a permanent public health benefit to future generations.

Further Reading

- Hay, S.I., C.A. Guerra, A.J. Tatem, A.M. Noor, and R.W. Snow. 2004. The Global Distribution and Population at Risk of Malaria: Past, Present, and Future. *Lancet Infectious Diseases* 4(6): 327–336.
- Institute of Medicine. 2004. *Saving Lives, Buying Time: Economics of Malaria Drugs in an Age of Resistance*. Washington, DC: National Academies Press.
- Roll Back Malaria Partnership. 2009. www.rollbackmalaria.org (accessed October 20, 2009).
- World Malaria Report 2005. World Health Organization. <http://rbm.who.int/wmr2005> (accessed October 20, 2009).

86. THE SPREAD OF MRSA

Antibiotic Resistance with a Name

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is a program fellow at Resources for the Future. Her work explores the growing resistance to antibiotic and antimalarial drugs, as well as access to and cost of such pharmaceuticals.

The rapid spread of the superbug MRSA in hospitals around the world, and the more recent spread of MRSA strains in the community, has heightened concern about the declining effectiveness of frontline drugs, as bacterial strains resistant to those drugs evolve. How is MRSA transmitted, why is it becoming more prevalent, and how many people are now dying because of it?

By now, almost everyone has heard of MRSA (methicillin-resistant *Staphylococcus aureus*)—variants of the ubiquitous staph bacteria that are resistant to penicillin and related antibiotics, the original “wonder drugs” that transformed the treatment of infectious diseases in the mid-20th century. Methicillin is the antibiotic named to signify bacterial resistance to the class that includes penicillins (even though bacteria are not routinely tested against it). Methicillin, no longer used because of its toxicity, was developed in 1959, a decade after bacteria resistant to penicillin arose (which occurred a mere four years after penicillin went into mass production). This is a lesson we still must heed today—that resistance is an inevitable natural phenomenon, bound to occur against every antibiotic the more it is used.

MRSA news stories tend to focus on healthy young victims who have picked up the bacteria on the football field, in school, or somewhere else in the course of daily living, and end up with an overwhelming infection that puts them into the intensive-care unit. MRSA may kill through infections of the lung, blood, or tissue (it’s one of the “flesh-eating bacteria”). What has happened to these victims is shocking and tragic, of course, but their cases represent just a small part of the larger MRSA problem. Sadly, the more numerous deaths of elderly hospital patients with serious medical problems are not exactly front page material.

Both MRSA and common staph are typically harmless on the surface: they can “colonize” the skin or the nasal passages without causing any health problems. When they enter broken skin through a cut or sore, however, they “infect” the surrounding tissue and proliferate in boils, blisters, or pimples. Often these skin and soft tissue infections can just be cleaned out and left to heal. But when bacteria invade the bloodstream, causing blood infections called septicemia or bacteremia, or the lungs, causing pneumonia, the situation becomes much more serious, and quickly. When these staph infections are MRSA, they take longer to cure, about doubling the time spent in the hospital, and also doubling the hospital bill.

Septicemia and pneumonia are almost exclusively acquired in hospitals or other health-care settings, where staph bacteria are ubiquitous if no special infection control measures, such as testing new patients and isolating those who are colonized, are in force. Bacteria can enter patients’ internal organs during surgery, around catheters used to infuse intravenous drugs and fluids, and around urinary catheters. The result can be deadly MRSA infections—especially in patients who are already weakened by illness or old age. Ironically, the infection vectors in hospitals are often health-care workers who become colonized and then spread the bugs around.

National and local publicity has raised public consciousness about MRSA, although it doesn’t inform us about the extent of the problem. RFF researchers Eili Klein, David Smith, and Ramanan Laxminarayan analyzed data from the past few years to answer that question, as part of Extending the Cure, an ongoing research project on antibiotic resistance. What their analysis (2007) tells us is that, unlike some health-scare stories that represent only a small risk, this one is growing and worth worrying about.

The fact that the development of new antibiotics is at an all-time low could turn this into a full-scale disaster—a return to the preantibiotic era, when ordinary infections were deadly.

Here are some basic statistics from *Extending the Cure*: MRSA infections treated in hospitals more than doubled nationwide between 1999 and 2005, from an estimated 127,000 to 278,000. MRSA also represents a growing proportion of staph infections seen in hospitals—from 40 percent in 1999 to 60 percent in 2005. The numbers themselves are difficult to verify and are the subject of controversy. Using a different data source and other methods, other researchers estimated that the national prevalence rate of MRSA among hospital patients in 2006 was five to eight times as high as what Klein and colleagues reported for 2005. Putting these differences in perspective, it's worth remembering the MRSA phenomenon is relatively recent: in the late 1980s, resistant staph bacteria accounted for perhaps 2 percent of infections.

Counting infections in hospitals is tricky, but the question of how many people die from MRSA is even more difficult and involves judgment calls. Many people who die entered the hospital because they had a life-threatening condition and were already advanced in age. In this context, any infection is more perilous than it would be for a healthy, young person: in other words, the infirm and elderly may die in the hospital even without MRSA.

This led Klein, Smith, and Laxminarayan to create two estimates of deaths attributable to MRSA. Using stricter criteria, they estimated about 5,500 deaths per year over the seven-year period, with no suggestion of a trend up or down. Using a more inclusive definition—everyone who died and had a documented case of MRSA during their hospitalization—the estimates were higher and rose steadily. In 1999, about 11,000 such deaths occurred, and by 2005, more than 17,300. Using similar definitions and entirely different data sources, two other groups of researchers came up with very similar results for deaths in 2005: from the Centers for Disease Control and Prevention (CDC), 18,650 deaths, and from the Agency for Healthcare Research and Quality, 17,300 deaths.

Patients hospitalized with MRSA infections included both those with septicemia and pneumonia who acquired their infections during their hospital stays and those more likely to

have picked up the infection in the community (skin and soft-tissue infections, mainly noninvasive). Septicemia cases increased 81 percent over seven years and pneumonias increased 19 percent. But the steepest increase by far was in the “community-associated” skin and soft-tissue infections, which nearly tripled between 1999 and 2005. Most deaths from MRSA still result from infections that take root in hospitals, but the community-associated MRSA burden is becoming increasingly important.

As important as it is to keep track of MRSA cases and count those who die from MRSA, it is even more important to institute preventive measures to reduce the spread of MRSA and other infections in hospitals, nursing homes, and other health care sites. We already know some measures that work—including testing patients (all or high-risk only) on hospital admission and isolating the ones who are colonized or infected, and implementing contact precautions for hospital workers (for example, keeping stethoscopes and other equipment in patients' rooms, promoting better hand hygiene by the staff). The other approach stems from that early lesson: antibiotics should be used to preserve health and save lives, but we should use them wisely, when they are the best course. Just knowing what works is not enough, however. The right incentives—both carrots and sticks—must be in place. That will require finding the precise mix of legislation, regulation, and economic incentives to improving infection control that will work, a hunt that cannot wait any longer.

Further Reading

- Jarvis, W.R., J. Schlosser, R.Y. Chinn, S. Tweeten, and M. Jackson. 2007. National Prevalence of Methicillin-Resistant *Staphylococcus aureus* in Inpatients at US Health Care Facilities, 2006. *American Journal of Infection Control* 35(1): 631–637.
- Klein, E., D. L. Smith, and R. Laxminarayan. 2007. Hospitalizations and Deaths Caused by Methicillin-Resistant *Staphylococcus aureus*, United States, 1999–2005. *Emerging Infectious Diseases* 13(12): 1840–1846.
- Klevens, R.M., M.A. Morrison, et al. 2007. Invasive Methicillin-Resistant *Staphylococcus aureus* Infections in the United States. *Journal of the American Medical Association* 298(15): 1763–1771.

87. CONTROLLING TUBERCULOSIS

What Is the Benefit, at What Cost?

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Sarah Darley

completed her work on this commentary while a full-time research associate at Resources for the Future.

This commentary discusses the widespread prevalence of tuberculosis in developing countries and estimates of the highly favorable cost–benefit ratio for potential interventions to contain the disease.

After HIV/AIDS, tuberculosis (TB) is the most important cause of adult mortality due to infectious disease in low- and middle-income countries. It accounted for some 1.2 million deaths in 2004 in the 22 countries identified by the World Health Organization (WHO) as “high burden.” (These countries constitute approximately 80 percent of global tuberculosis cases.) The advent of antibiotics was once thought to herald the end of TB, or “consumption,” the wasting disease caused by a lung bacterium, but in many of these countries, poor sanitation, high rates of HIV infection, and drug-resistant strains of the bacterium have allowed tuberculosis to spread.

Tuberculosis is a contagious disease, spread through the air via coughing, sneezing, or even talking. In its most common form, known as pulmonary TB, the bacteria attack the lungs and can cause chronic coughing (often with bloody sputum), fever, and weight loss. WHO estimates that, left untreated, each person with pulmonary TB will infect on average 10 to 15 people every year.

Weakened and unable to work, once-productive adults who have contracted the disease must be cared for by other members of their families, putting the caregivers at greater risk of infection and lowering their own productivity. The cost of treatment can account for as much as 8 to 20 percent of annual household income, but without it, most people die within 18 months of being infected. The burden of TB is borne not just by those afflicted and their families, but also by communities and governments. Adult mortality dampens national economies by claiming productive workers. People are reluctant to invest in education or take entrepreneurial risks if they don't expect to live long enough to see the payoff, and they tend to have more children and invest less in their offspring.

Lifting the burden is one of the UN's Millennium Development Goals—specifically, reversing the incidence of TB by 2015. The Stop TB Partnership goes further and aims to halve prevalence and death rates by 2015, relative to 1990. One of the tools for reaching either target is “directly observed treatment, short-course,” or DOTS, in which patients take their drugs under a health worker's supervision (to ensure that they get the recommended doses at the appropriate intervals).

Determining the benefits of achieving the goals begins with quantifying the economic costs of not achieving the goals: how much does TB cost society? What is the economic burden of not doing more than is being currently done to prevent and treat the disease?

To address these questions, we turned to a widely used concept in economics, the value of a statistical life (VSL), which puts a value not on person X's worth as a human being, but rather on measures that people are willing to undertake (such as buying safer cars or choosing safer occupations) that can reduce the statistically expected number of deaths by one. EPA recommends a VSL of \$6.1 million (in 2004 dollars) for the United States, which, adjusted for differences in per capita income between the United States and low-income countries, translates into VSL estimates from \$23,000 for Zimbabwe to nearly \$1 million for the Russian Federation. To assess the economic burden of TB, we first must ask, how many people will die of TB in the 22 high-burden countries from 2006 to 2015? The WHO epidemiological models consider

three scenarios:

- No DOTS: the program was never introduced, case detection rates are variable, rates of cure are low;
- Sustained DOTS: case detection and treatment success rates are sustained at the 2005 level to 2015; and
- Global Plan to Stop TB 2006–2015: DOTS coverage is expanded, programs address TB-HIV coinfection and drug-resistant TB, and infections are targeted with new diagnostics, medicines, vaccines, and educational efforts.

We estimated the economic cost of projected TB deaths under those three scenarios, factoring in average age of death from TB, life expectancy for TB-HIV coinfection cases, and so forth. We also calculated the costs of implementing health interventions to improve TB control (including the welfare losses associated with raising the necessary funds from national tax revenues). On the flip side, we calculated the benefits of averting deaths (saving lives) through improved TB control.

With No DOTS, we found that the economic burden of deaths associated with TB and TB-HIV between 2006 and 2015 in the 22 high-burden countries would be roughly \$3 trillion, including \$1.175 trillion in China and \$519 billion in the African countries. This is, of course, only a hypothetical scenario because DOTS is being implemented in all TB-endemic countries, but it serves as a useful benchmark against which to calibrate our assessments of Sustained DOTS and the Global Plan.

Sustained DOTS would cost \$18.3 billion to implement but deliver a dramatic economic gain of \$1.6 trillion. The cost-benefit ratio of moving from No DOTS to Sustained DOTS is about 10 to 1—a very healthy return on the investment.

In the final scenario, the full Global Plan version of DOTS would cost \$33.2 billion to implement and yield a gain of about \$1.9 trillion compared with No DOTS. This is a relatively small incremental improvement over Sustained DOTS, but the benefits still exceed the costs in the African countries.

The economic burdens of TB deaths and the benefits of TB control are greatest in China and India, where the combination of growing incomes and high numbers of TB deaths multiplies into a significant economic effect. Although more TB deaths occur in the African countries, the economic benefit of either Sustained DOTS or Global Plan DOTS is more modest here, partly because incomes are expected to grow more slowly than in Asia, and partly because the benefits of treatment in Africa slip away when HIV claims lives that would otherwise be saved from TB. Nevertheless, the benefits of the Global Plan are highest in the African countries with high levels of HIV. Because the economic burden of TB in Africa is significant, the benefits of either DOTS strategy are large and exceed the costs by a wide margin.

While progress is being made, challenges such as funding gaps, higher-than-expected incidence rates through the 1990s, HIV coinfection, and multidrug resistance point to the urgent need for more comprehensive action to control TB. Fortunately, the state of our knowledge means that TB control is not a question of whether, but of how and how much we will commit to do. The significant economic benefits of taking action indicate that there is no reason we cannot do more to tackle this disease—the up-front costs are more than outweighed by the decades of not only health, but also productivity and prosperity that would follow.

Further Reading

- Aldy, Joseph E., and W. Kip Viscusi. 2008. Adjusting the Value of a Statistical Life for Age and Cohort Effects. *Review of Economics and Statistics* 90(3): 573–581.
- Dye, C. 2006. Global Epidemiology of TB. *Lancet* 367: 938–940.
- Dye, C. and K. Floyd. 2006. Tuberculosis. In *Disease Control Priorities in Developing Countries*. 2nd ed., edited by D. T. Jamison. New York: Oxford University Press, 289–312.
- Laxminarayan, R., E. Klein, S. Darley, and O. Adeyi. 2009. Global Investments in Tuberculosis Control: Economic Benefits. *Health Affairs* 28(4):730–742.

88. BRINGING OUR FOOD SAFETY SYSTEM INTO THE 21st CENTURY

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In recent years, foodborne illness incidents have been prominent in the news, and Congress has been holding hearings to determine what can be done. How and where does U.S. food safety policy need to change in order to ensure public safety in the face of our rapidly changing food supply system?

Over the past two years, a succession of cases of foodborne illnesses, many serious and some even fatal, has raised questions about the effectiveness of the U.S. food safety system. Our current system is based on procedures that have accumulated over the past century in response to various crises, scandals, and discoveries. Some are now seriously out of date. In other cases, new issues have emerged that the system was never designed to address.

The problem, at its root, is that hazards, foods, food sources, and food marketing are all changing rapidly, while our policies are not. Our meat inspection is governed by a 1906 act that still mandates visual inspection of every carcass processed in the country. Yet today's major hazards are microbial. New problems arise regularly and sometimes unpredictably. *E. coli* O157:H7, a potentially lethal bacterium, wasn't even recognized as a foodborne pathogen until 1982.

Changes in products and processes can create unforeseen problems. For example, a major shift has occurred in how ground meat is processed: today, meat from multiple sources is blended in large batches and distributed across the country, creating heightened potential for product contamination and illness. Another significant shift is the growing amount of food we now import. Consumers certainly benefit from flexibility in the food supply through lower prices, greater variety, and better nutrition throughout the year. But those benefits may be coming at the cost of increased risk.

The right response is to start thinking about food safety policy as a problem in modern risk management. In this context, risk management involves the ability to monitor changes in food safety risks systemwide in something like real time and the flexibility to redeploy resources to control these risks as needed. Carrying this out will involve recognizing who has least-cost access to information on how risks are generated and can most efficiently be controlled, and using this knowledge in designing policy. The United States, largely at the initiative of federal agencies and industry, has moved in this direction for the past two decades. But this effort has been seriously hampered by antiquated legislation and severe federal funding cuts.

SPECIFIC NEEDS

Better public health information. Information is the foundation for risk management. It is surprisingly difficult to estimate the rate of foodborne illness because often the link to food goes unrecognized. The most widely cited estimates date from 1999. Death estimates are highly uncertain because we do not have a good understanding of the longer-term effects of foodborne illness, such as links to heart disease. In the 1990s, significant efforts were made to establish better active surveillance of foodborne illness, but lack of funding has limited its scope to 10 states and a few localities. Passive surveillance relies both on local doctors reporting foodborne illness to local health authorities and on highly variable state and local public health funding.

Flexible, systemwide, risk-based regulation. Another positive change would be expansion of regulatory approaches that reflect the information constraints and comparative strengths of the public and private sectors. Hazard Analysis and Critical Control

Point (HACCP) regulations are a step in that direction. They require firms to identify where foodborne illness hazards are most likely to arise in their operations and to develop processes for controlling these critical points. Government's role is to verify that the firms are actually carrying out this process.

In the past decade and a half, HACCP regulations have been designed for meat, poultry, seafood, and juice. While these regulations make use of firms' informational advantages and provide firms the flexibility to adapt to changing technology and market demands, they do not adequately address the inherent conflicts of interest. Consumer groups have rightly pushed for more effective verification that these systems are not just in operation, but are actually controlling hazards. Court rulings and lack of legislative authority have prevented agencies from using product testing as a full-fledged enforcement mechanism. Third-party certification systems have also been used successfully by other industrialized countries.

Expansion of a HACCP-like approach beyond the processing and packing plant to across the full food supply chain would be helpful. Pathogen testing at retail may soon be technically feasible. Having checks on product contamination at critical junctures—like retail or the end of processing—coupled with product condemnation, recall, public information, and liability could provide powerful incentives for product safety down the supply chain. Trace-back systems are being used by private industry to identify the source of safety failures. These need broader use in public policy.

Risk management of imports. Roughly 45 percent of fresh fruit and 80 percent of seafood consumed in the United States is now imported. Globalization of the U.S. food supply poses three major challenges: volume, rapidly changing sourcing (particularly for food additives), and enforcement. Given the increasing volume of imports, border inspection alone will not assure safety. With more and more countries exporting to the United States, it is also unlikely that in-country inspection will fully address the problem. Extension of HACCP-like approaches to supply chain management for vertically integrat-

ed firms and use of third-party certification will have to play an increased role. And government needs to police conflicts of interest in these systems and to verify that certification systems are doing their job.

An end to fragmented federal governance. The pizza in your freezer complies with food safety regulations from six different federal agencies. Despite significant effort at coordination through interagency agreements, this fragmentation of authority—with the predictable turf battles, competition for budgets, and quarrels over priorities—remains a fundamental problem. But agency unification without legislative reform that authorizes modern approaches to regulation and allows flexible deployment of resources to focus on the most cost-effective opportunities for risk reduction will do little good.

Developing a risk-based food safety system, and pulling together a unified agency to administer it, would require a major reconstruction effort by the White House and Congress. That kind of effort most commonly occurs only after a disaster. The question is whether the political process can achieve a reform of such complexity without first paying the heavy price that a serious breakdown in food safety would exact.

Further Reading

- Garcia, Marian, Andrew Fearne, Julie A. Caswell, and Spencer Henson. 2007. Co-regulation as a Possible Model for Food Safety Governance: Opportunities for Public-Private Partnerships. *Food Policy* 32(3): 299–314.
- Golan, Elise, Tanya Roberts, Elisabete Salay, Julie Caswell, Michael Ollinger, and Danna Moore. 2004. *Food Safety Innovation in the United States: Evidence from the Meat Industry*. Agricultural Economic Report No. AER-831. Washington, DC: U.S. Department of Agriculture.
- Hoffmann, Sandra. 2007. Mending Our Food Safety Net. *Resources* 166: 11–15.
- Hoffmann, Sandra, and Michael Taylor, eds. 2005. *Toward Safer Food: Perspectives on Risk and Priority Setting*. Washington, DC: RFF Press.

89. TOBACCO TAXATION IN THE EUROPEAN UNION AND UNITED STATES

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Tobacco tax systems differ across countries with regard to not only the overall tax level, but also the mix between specific and ad valorem taxes. What does economics have to say about how governments should tax tobacco?

Both the level and the structure of tobacco taxes differ markedly between, as well as within, the European Union and United States. (The focus here is on cigarettes alone, as they constitute over 90 percent of tobacco consumption.) Within EU member states, the total tax burden (excises and value added taxes, or VAT) is around three-quarters of the retail price of cigarettes, or over 300 percent of the pretax price. The southern member states favor predominantly ad valorem taxes (that is, percentage rates on the value of a pack of cigarettes), whereas in the northern member states, specific taxes constitute more than half of the total tobacco tax burden.

In the United States, tobacco taxes are almost wholly specific. The federal government levies a tax of 39 cents per pack (of 20 cigarettes), state governments levy taxes that average about 60 cents per pack, and the Master Tobacco Settlement Agreement, concluded in 1998 (under which tobacco companies are expected to pay \$206 billion to settle product liability suits) effectively added a further 30 cents per pack. Nonetheless the total tax (excise and retail sales taxes), about \$1.30 per pack, amounts to about 37 percent of the retail price, or about half the rate in the European Union.

What does economics have to say about the appropriate level, and structure, of tobacco taxation?

WHAT COSTS DO SMOKERS IMPOSE ON OTHERS?

The causal link to future health problems from smoking is extremely well documented—smoking is a primary cause of lung cancer, emphysema, chronic bronchitis, and a major cause of heart disease and stroke. Smoking by pregnant women leads to low birth weight babies, neonatal death, and sudden infant death syndrome.

While the health consequences of smoking are important, in principle they are irrelevant to public policy unless the costs imposed are external (that is, imposed on others rather than borne privately by the smoker). The principle of consumer sovereignty implies that a rational person who weighs all the costs and benefits of his actions should be free to smoke as long as he does not impose costs on others and is fully informed about the consequences of his choices.

Virtually all empirical research suggests that the external costs of smoking are relatively small. The burden of medical payments on government due to smoking-related illness is one potential source of external cost. However, this near-term burden is at least partly offset in a life-cycle context, as the average smoker lives a shorter life, which saves on pensions and health-care costs of age-related disease. Bans on smoking in public places have greatly reduced the external costs of environmental or “second-hand” tobacco smoke. However, little has been or can be done about the health problems experienced by children and nonsmoking partners within the family at home. Perhaps economists assume too easily that such costs are largely internalized by the smoker through altruism or negotiation among family members.

INFORMATION AND ADDICTION FAILURES

If smokers, especially teenagers, are poorly informed about the costs of smoking, then

to that extent, the costs of smoking are effectively external. However, if inadequate information is the problem, this is best addressed through warning labels and information dissemination programs about health hazards. In fact, evidence suggests that 90 percent of U.S. consumers are aware of the long-term health effects of smoking.

Nonetheless, the fact that nicotine is addictive may undermine the consumer sovereignty argument against government intervention. If smokers behave myopically in choosing to consume an addictive drug, the rationality condition ceases to apply, because the addictive smoker is, to some extent, a different person than the one who decided to start smoking. Furthermore, consumers may excessively discount the longer-term costs of addiction. Consequently, they may therefore have self-control problems, referred to as internal costs, where they continually plan to smoke less in the future than they actually can. In this case, cigarette taxes may help to reinforce a commitment to quit in the future.

In fact, higher taxes seem to be most effective in reducing smoking prevalence among teenagers who are better able to kick the habit, because addiction has not yet taken hold. Evidence suggests that a 10 percent increase in cigarette prices is associated with about a 4 percent reduction in smoking among adults, but an 8 percent reduction among teenagers.

Evidence suggests that tobacco tax levels, even in the United States, are difficult to justify on externality grounds, let alone those levels prevailing in the European Union. High taxes may reflect a form of paternalism, such as a desire to discourage young people from taking up smoking. The internal cost argument for higher taxes has not yet been settled.

WHAT'S THE RIGHT WAY TO TAX TOBACCO?

Tobacco is far from a homogeneous product. The United States and northern European countries tend to produce higher-quality brands than southern European countries. Ad valorem taxes raise the prices of different brands in the same proportion, and therefore they do not distort a consumer's choice between high- and low-quality brands. This makes economic sense, to the extent that the purpose of tobacco taxes is to raise revenue.

Taxing cigarettes according to their external costs leads to a very different conclusion, however. The damage caused by cigarette smoking is independent of the price at which it is

sold, so that correction of externalities favors specific over ad valorem taxes. All else equal, the share of specific taxes in total tobacco taxation should be smaller when the importance of raising revenue is greater and the case for correcting externalities correspondingly smaller. To some extent, this reasoning is consistent with the high ad valorem tax element in EU tobacco tax systems and its absence in U.S. structures.

Some variation in specific taxes across different tobacco products may in fact be appropriate. Since health damages are correlated with the tar content of cigarettes, taxes on high-tar cigarettes should be higher too. However, some research shows that addicts smoke low-tar and low-nicotine cigarettes differently, inhaling more to increase the amount of nicotine they ingest. So corrective taxes might not be proportional to tar content, but some differentiation is likely to still be appropriate. Moreover, a "tar tax" would give manufacturers an incentive to develop palatable low-tar cigarettes, which would have long-term health benefits.

A COMPLEX QUESTION

The question of what the right level and structure of tobacco tax should be is a complex one, given the multiple objectives of policymakers. The reasons for levying high taxes on tobacco products are the predictability of the revenue, the desire to discourage youths from taking up smoking, and the belief that smokers should pay for the burden they impose on others. The reasons for moderating the level of tobacco taxes are the principle of consumer sovereignty and the finding that the external costs of smoking may be low. And the choice between specific and ad valorem taxation depends on whether the primary goal of policy is to discourage smoking or raise revenue.

Further Reading

- Chossen, Sijbren, and Michael Smart. 2005. Taxation of Tobacco. In *The Theory and Practice of Excise Taxation*, edited by Sijbren Cnossen. Oxford, UK: Oxford University Press.
- Manning, Willard G., Emmet B. Keeler, Joseph P. Newhouse, Elizabeth M. Sloss, and Jeffrey Wasserman. 1989. The Taxes of Sin: Do Smokers and Drinkers Pay Their Way? *Journal of the American Medical Association* 261: 1604–1609.

90. HOW ADVERTISING FOR SMOKING-CESSATION PRODUCTS CAN HELP MEET PUBLIC HEALTH GOALS

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Although progress has been made, smoking remains a leading cause of death in the United States. To what extent do advertisements for smoking-cessation products encourage people to quit smoking, and how might the regulation of such advertising be reformed?

About 20 percent of the U.S. adult population currently smokes cigarettes, and over 400,000 Americans die each year from smoking-related illnesses. Given these stark numbers, it is easy to understand why an ongoing federal public health initiative aims to cut the smoking rate almost in half by 2010. Over the past decade or so, preventing youths from starting to smoke attracted a great deal of media and policy attention. Taxes were raised, antismoking mass media campaigns were launched, and laws restricting the sale of cigarettes to minors were strengthened and enforced.

While it is difficult to know which, if any, of these policies worked, the rate of daily smoking among high school seniors indeed dropped by half from the peak levels reached in the late 1990s. But the remaining gap between the current adult smoking rate and the new goal makes clear what experts have long recognized: large reductions in the smoking rate cannot be achieved unless more of the 45 million adults who currently smoke quit. And as one of the required cigarette warning labels reads: “Quitting smoking now greatly reduces serious risks to your health.”

Thinking about smoking cessation as a public health problem naturally focuses attention on public policies such as further cigarette tax hikes, smoking bans, and stronger warning labels. However, it is also a private health issue—the smokers themselves have the most to gain from quitting. There is a healthy private-sector market for products such as nicotine gum that help smokers quit. The pharmaceutical industry’s estimated retail sales of smoking-cessation products are nearly \$1 billion annually. In recent years, the industry has spent between \$100 million and \$200 million annually advertising these products. While the pharmaceutical industry is out for higher profits, does the advertising also improve public health? If so, what public policies might encourage more private-sector advertising?

To shed new light on this question, we studied whether pharmaceutical industry advertising affected smokers’ decisions to quit. The research team included our colleagues Rosemary Avery and Alan Mathios, as well as undergraduate and graduate research assistants. We linked survey data from individual smokers with an archive of magazine advertisements. With data on these smokers’ magazine reading habits, we measured the smoking-cessation ads to which they were exposed. By using the same information about the consumers that the advertisers observe, we tried to control for the potential reverse causality that advertising studies commonly face: are consumers responding to the advertising, or are advertisers responding to the consumer behavior?

After subjecting our results to a battery of checks, we found evidence that, when smokers see more magazine ads for smoking-cessation products, they are more likely to decide to quit. Based on our results, we estimate that if the smoking-cessation product industry increases its average annual expenditures on magazine advertising by about \$2.6 million, the average smoker would be exposed to about 2.1 more magazine ads each year. According to our empirical models, the result would be about 225,000 new attempts to quit and 80,000 successful “quits” each year. If an increase of this size in the rate of smoking cessation could be maintained over the years, the adult smoking rate would drop by about a percentage point. Larger increases in advertising

budgets could reduce smoking rates by even more. Our study of smoking-cessation product advertising is part of a growing body of economic research finding that direct-to-consumer ads increase consumer demand for a variety of pharmaceutical products.

Interestingly, however, our estimates show that most of the new quit attempts and quits spurred by the ads would not involve the purchase of smoking-cessation products. Other studies find that when smokers attempt to quit, at least two-thirds use a method like going “cold turkey” that does not involve a product purchase. Likewise, our estimates suggest that about two-thirds of smokers who were prompted to quit by the product ads will also go cold turkey.

Firms often worry that their ad expenditures will spill over and help their competitors: does a McDonald’s ad prompt a visit to the Golden Arches, or might it help Burger King too? But for smoking-cessation products, the direct competition doesn’t cost anything. Because advertising can spur people to quit on their own, some of the public health returns to smoking-cessation product ads are not captured as private profits.

The standard policy prescription is to use subsidies to encourage private-sector activities that generate positive spillovers. For example, the public sector subsidizes education because schooling not only helps the recipients, but also presumably benefits the rest of society. However, instead of subsidizing pharmaceutical ads because of their spillovers, current regulatory policy works to discourage them. The United States and New Zealand are the only countries that allow direct-to-consumer advertising of prescription pharmaceutical products. Even in these two countries, these ads are strictly regulated.

In the United States, this had led to an ironic situation: in some ways, ads for prescription pharmaceutical products

for smoking cessation have been more heavily regulated than cigarette ads. Food and Drug Administration (FDA) regulations require magazine ads for prescription smoking-cessation products to include at least an extra page of disclosures about side effects and contraindications, while cigarette ads are required to carry only a short warning label. Easing regulations on ads for smoking-cessation products could exploit more fully the profit incentives to promote public health. Ads for other pharmaceutical products, such as statins to treat high cholesterol, have similar potential. Because the potential gains and harms from advertising vary widely across products, it might make sense for the FDA to adopt a more flexible approach to regulating direct-to-consumer advertising.

More generally, when crafting public policy, it is important to acknowledge private incentives to improve public health. People want to live healthier and longer lives, and private-sector firms can earn profits helping them do so. Public policies should be structured to facilitate, rather than impede, the public health gains enjoyed when firms pursue private profits.

Further Reading

- Avery, Rosemary, Donald Kenkel, Dean Lillard, and Alan Mathios. 2007. Private Profits and Public Health: Does Advertising of Smoking Cessation Products Encourage Smokers to Quit? *Journal of Political Economy* 115(3): 447–481.
- Avery, Rosemary, Donald Kenkel, Dean Lillard, and Alan Mathios. 2007. Regulating Advertisements: The Case of Smoking Cessation Products. *Journal of Regulatory Economics* 31: 185–208.
- Chaloupka, Frank, and Kenneth Warner. 2000. The Economics of Smoking. In *Handbook of Health Economics*, Vol. 1B, edited by Anthony J. Culyer and Joseph P. Newhouse. Amsterdam, Netherlands: North-Holland.

91. MERCURY ADVISORIES FOR COMMERCIAL FISH

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In recent years, environmental policymakers have supplemented traditional pollution regulations with information disclosure programs to better inform the public about the health and other environmental risks of products and firm activities. Mercury advisories are one example of this approach, but the program has had some unintended consequences.

In the last several years, concern has arisen that mercury from commercial fish consumption may pose a significant threat to children's neurological development. In 2001, the FDA responded to increasing risk information by releasing a national advisory. It warned pregnant women, women who may become pregnant, and households with young children to limit their fish consumption. An advisory update was issued in 2004. Both advisories instructed at-risk groups to eliminate consumption of certain types of fish and cap consumption of all seafood, including canned fish.

To better understand this ongoing public health issue, it is useful to provide some context. Levels of mercury circulating in the environment have increased considerably over the last century. Coal-fired power plants are currently the largest source of anthropogenic mercury. When atmospheric mercury is deposited into surface water, bacteria convert the mercury into organic methylmercury. This then enters a fish's bloodstream from water passing over its gills and accumulates in tissues. It also bioaccumulates up the food chain. Even in water where ambient mercury levels are extremely low, methylmercury concentrations may reach high levels in predatory species like tuna, king mackerel, swordfish, and shark.

For the general public, fish consumption is the primary source of exposure to mercury. Cooking and other forms of food preparation do not mitigate the risks. The FDA and other government agencies maintain that even modest mercury concentrations pose a risk of significant harm to the developing neurological systems of fetuses, infants, and young children. Consequences may include reduced IQ, learning and attention disorders, and generally slowed intellectual and behavioral development. Severe neurological illnesses, like cerebral palsy, may result from unusually high exposure. In adults, abnormally high mercury concentrations may contribute to brain damage, heart disease, blurred vision, slurred speech, and other neurological ailments, although such high concentrations are rare.

Conventional economic wisdom tells us that improved information, such as the content of the mercury advisories, will make consumers better off. Indeed, there are theoretical advantages of managing mercury risks with consumption advisories. First, advisories provide flexible risk mitigation. They can directly target at-risk households and do not impose undue costs to society by limiting exposure to consumers that are not susceptible to risk. Second, information policies allow risk mitigation for persistent problems. Even if mercury emissions could be completely eliminated, health risks could not be ruled out in the short run, because mercury persists in the environment. Third, advisories allow risk mitigation for problems that cross boundaries. A complete ban on domestic mercury emissions would still not rule out health risks to American consumers, even in the long run, because the vast majority of seafood consumed in the United States is caught abroad. To complicate matters further, mercury emissions from foreign sources are often deposited in U.S. waters.

Despite the theoretical advantages of mercury advisories for managing risks, the big question is whether those advisories actually work in practice. Recent research

suggests there may be serious limitations. Because a moderate amount of fish consumption provides significant health benefits to both adults and children—particularly in the form of IQ, stroke, and heart disease benefits from omega-3 fatty acid intakes—crude advisory responses or overreactions may mitigate advisories' net public health effects. In short, there is a tension between mercury risks and seafood's health benefits. Some members of the scientific community have even speculated that mercury advisories may have caused net harm if at-risk consumers responded to the advisories by reducing consumption of all fish rather than high-mercury fish alone.

A colleague and I have shown that this speculation is justified (Shimshack and Ward 2008). We found that at-risk consumers did reduce mercury intakes in response to the 2001 commercial fish advisory. In isolation, this is positive for public health. However, we also found that at-risk consumers substantially reduced their intake of beneficial omega-3 fatty acids. Further explorations revealed that at-risk consumers did not substitute high-mercury fish with low-mercury fish, nor did they differentially avoid high-mercury fish. They simply reduced consumption of all fish in response to the advisory. When we interpreted our results from a public health perspective, we found that the benefits of mercury reductions were approximately offset by the negative health effects of reduced overall fish consumption. In other words, on net, we found no public health benefits of the mercury advisory.

Other concerns about mercury advisories also exist. Co-authors and I found that advisories affect households differently (Shimshack et al. 2007). Important groups of at-risk consumers, including the least educated, did not seem to react to mercury advisories at all. This may be a notable public health issue, because this group of consumers may be particularly poorly equipped to withstand negative health outcomes.

Unintended spillover effects of these advisories are another factor. We found that some consumers not considered at-risk also reduced consumption in response to the advisory—an outcome not consistent with policy goals.

In sum, the evidence justifies strong cautionary notes about commercial fish advisories. While the theoretical advantages of information policies for managing mercury in seafood are significant, the practical realities highlight important disadvantages. More research is needed, but the best available evidence suggests that national commercial fish advisories have no net public health benefits. Advisories must be more carefully crafted and disseminated. Mercury mitigation strategies might also appropriately begin to rely more on emissions reductions than consumption advisories alone.

Further Reading

- Cohen, Joshua, et al. 2005. A Quantitative Risk-Benefit Analysis of Changes in Population Fish Consumption. *American Journal of Preventive Medicine* 29(4): 325–334.
- Shimshack, Jay P., Michael B. Ward, and Timothy K.M. Beatty. 2007. Mercury Advisories: Information, Education, and Fish Consumption. *Journal of Environmental Economics and Management* 53: 158–179.
- Shimshack, Jay P., and Michael B. Ward. 2008. Mercury Advisories and Household Health Trade-offs. Working paper. February. New Orleans: Tulane University.
- U.S. National Academies, Food and Nutrition Board. 2005. *Seafood Choices: Balancing the Benefits and the Risks*. Washington, DC: National Academies Press.

92. MEASURING THE BENEFITS OF REDUCED EXPOSURE TO LEAD

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For many air pollutants, the most important health hazard is premature mortality. However, in the case of lead emissions, the main health risk is neurological damage to young children. How do economists measure the benefits of reducing lead emissions, and what are the implications for the recent tightening of the lead standard?

Although lead was outlawed from use in gasoline and paint in the 1970s, many children in this country continue to be exposed to lead in dust, soil, and deteriorated paint in housing units. Efforts to cut the use of this neurotoxin in other products—such as foods, cosmetics, folk remedies, and toys—continue because exposure is known to be harmful, particularly in utero and in early childhood.

In fact, thousands of scientific studies over the last two decades have shown that young children suffer neurological harm at much lower blood lead levels than previously recognized, with potentially serious implications for brain development and cognitive abilities as well as noncognitive ones, such as motivation, perseverance, and tenacity. This was a major motivation behind a recent court challenge that resulted in a dramatic tightening in the National Ambient Air Quality Standard for lead (due to take effect by 2017) to 0.15 micrograms per cubic meter. The previous standard, set in 1978, had been 1.5 micrograms per cubic meter.

So is this change justifiable? Do the social benefits from reducing lead emissions outweigh the costs? Economists address these questions by doing the following:

- determining the impact of the control policy on reducing the atmospheric concentration,
- assessing the exposed population that potentially benefits from the reduction in ambient concentrations,
- estimating the reduction in blood lead levels for the affected population,
- evaluating the resulting health benefits, and
- obtaining a monetary measure of these benefits.

The first four steps can be measured by linking emissions/air quality models to local population data, as well as evidence from the scientific literature. The final one is our focus here, as this is perhaps the most contentious.

The benefits of reducing exposure to lead are based on estimated changes in mental ability—usually measured by changes in IQ—in children aged seven and below, and associated changes in their future earnings potential. EPA's regulatory impact assessment for the new lead standard assumed that each 1 percent increase in IQ would increase lifetime earnings by around 1.8 to 2.3 percent. But the reliability of these assumptions is open to question. Would alternative assumptions alter economic assessments of the desirability of previous policies to reduce lead emissions?

The EPA assumption was based on earlier studies, for example by Salkever (1995). The estimates of the IQ premium in those studies were obtained by comparing lifetime earnings of individuals—which depend on their wages and fringe benefits, hours worked, and likelihood of employment—with different IQ levels, holding other factors, like occupation or age, constant.

However, recent analyses appear to cast some doubt on these earlier findings. Heckman et al. (2006) developed better measures to take into account the quality of people's education, finding that, for 30-year-old men, a 1 percent difference in

cognitive ability made only a 0.6 percent difference in hourly wages—less than a third of EPA’s assumption. (However, this was exclusively for relatively young men, for whom the estimated association between IQ and earnings is somewhat weaker than for older men and for women.) Another study, by Zax and Rees (2002) estimated the wage premium at 0.6 to 1.4 percent for men.

The more recent evidence suggests that the association between cognitive ability and earnings has previously been overstated, and, by implication, the EPA regulatory impact analysis may have overstated the benefits of reducing children’s exposure to environmental lead. For example, Grosse et al. (2002) estimated that reductions in lead exposure from the mid-1970s to the late 1990s increased the total lifetime productivity of each year’s U.S. birth cohort by \$110 billion to \$320 billion. Based on the newer Zax–Rees figures, the estimates would fall to \$70 billion to \$150 billion.

Nonetheless, even these lower benefit figures are large relative to estimates of the annualized costs of phasing out leaded gasoline and paint, and other control measures. Moreover, the benefit estimates would be higher if recent findings were taken into account that link adverse health impacts to relatively low blood lead levels. Furthermore, the Grosse et al. estimate did not account for lead’s effects on noncognitive functioning, such as the ability to show up for work and focus on a task. Some studies find that those types of abilities or personality traits may be an even more important determinant of earnings than cognitive ability (Heckman et al. 2006). Nor did the study account for the possible association between lead exposure in childhood and criminal behavior among adults. Interventions in childhood that reduce criminal behavior in adulthood can generate very large economic returns.

As for the recent tightening of the lead standard, cost–benefit analyses are less conclusive, as the results are sensitive to

different assumptions, such as the rate at which higher future earnings are discounted. Scaling back the benefits in the EPA regulatory impact assessment (which include some side benefits from related reductions in particulate emissions) to account for the smaller earnings/IQ association leaves an overall net benefit under some range of assumptions and a net loss under others. Therefore, it appears difficult to make a definitive case for or against a tighter standard at this time. Perhaps new assessments will be more positive down the road, if some broader benefits of reduced lead poisoning, noted above, are quantified and taken into account, and if firms develop innovative, lower-cost ways to reduce lead emissions.

Further Reading

- Grosse, Scott D., Thomas D. Matte, Joel Schwartz, and Richard J. Jackson. 2002. Economic Gains Resulting from the Reduction in Children’s Exposure to Lead in the United States. *Environmental Health Perspectives* 110(6): 563–569.
- Heckman, James J., Jora Stixrud, and Sergio Urzua. 2006. The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior. *Journal of Labor Economics* 24: 411–482.
- Salkever, David S. 1995. Updated Estimates of Earnings Benefits from Reduced Exposure of Children to Environmental Lead. *Environmental Research* 70: 1–6.
- Zax, Jeffrey S., and Daniel I. Rees. 2002. IQ, Academic Performance, Environment, and Earnings. *Review of Economics and Statistics* 84: 600–616.

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93. INDOOR AIR POLLUTION AND AFRICAN DEATH RATES

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Indoor pollution from combustion of traditional cooking and heating fuels is a major health problem in low-income countries. Although there is little prospect of addressing this problem through electrification in the next 20 to 30 years, policy interventions, such as encouraging use of less-polluting fuels and stoves with better ventilation, can bring substantial health benefits in the meantime.

In sub-Saharan Africa, 94 percent of the rural population and 73 percent of the urban population use biomass—wood, charcoal, crop residues, animal dung—and coal as their main sources of energy for cooking and heating. Biomass combustion, particularly in open or poorly ventilated stoves, generates numerous pollutants, including particulate matter, carbon monoxide, and other carcinogens that are potentially harmful to the health of poor adult women and their children (who are carried on their mothers' backs or play by the fire).

Robert Bailis, Daniel Kammen, and I estimated that, for the year 2000, 350,000 sub-Saharan African children who died of lower respiratory infections, and 34,000 adult women who died of chronic obstructive pulmonary disease, would have lived longer had they not been exposed to indoor air pollution caused by burning biomass. Worldwide, studies suggest that exposure to indoor air pollution is responsible for over 1.8 million premature deaths a year, and nearly 3 percent of the global burden of disease. And all these figures may substantially underestimate the true disease burden. Recent evidence suggests an association between exposure to indoor air pollution during pregnancy and low birth weight, which has significant health consequences for adults and children.

Indoor air pollution from solid fuels is now recognized as a major global health concern. For example, solid-fuel use is an indicator for Goal 7 (environmental sustainability) of the UN's Millennium Development Goals. Exposure to indoor air pollution depends critically on household access to, and choice of, energy technology (that is, the choice of fuel and stove). The greatest risk reductions can be achieved by a complete transition to electricity, or even to direct use of fossil fuels like natural gas and kerosene. (Although the health risks of poisoning or burns from kerosene have not been systematically quantified, they are likely much smaller than the health risks from biomass and coal.) In many developing countries, especially in urban areas, high-income households have transitioned to cleaner fuels. There are, however, important exceptions to this: in China, for example, rapid economic growth and infrastructure expansion have contributed to near-universal access to electricity, yet almost 80 percent of households continue to use biomass or coal as their main energy source for cooking and heating.

In fact, for many low-income nations and households, particularly in rural sub-Saharan Africa, transitioning to clean fuels is not a realistic option for the next 20 to 30 years. One reason is the high up-front costs of the infrastructure needed to generate, process, and deliver clean energy. In Kenya, for example, a gas stove and tank costs around \$30–\$50, while a charcoal stove costs \$3–\$5. Another obstacle is the volatility in petroleum-based fuel prices, caused by both instability in international fuel markets and domestic energy policies.

In the meantime, efforts should therefore focus on interventions to modify aspects of the current fuel–stove combinations and energy-use behaviors, and to improve technologies for accessible and clean energy sources. Options include preprocessing

biomass and coal to burn more cleanly, and stoves with better ventilation. Separating kitchens or providing additional windows can also reduce pollution exposure. Interventions like these need to take into account local factors like climate and the environment, the purpose of energy use (cooking versus heating), local infrastructure, socioeconomic circumstances, and user behavior.

One particularly important intervention for very low-income societies is greater use of transformed biofuels. Evidence suggests that a substantial portion of the potential health risk reduction from a transition to petroleum-based fossil fuels could still be achieved by shifting toward charcoal. For example, based on current trends in the use of traditional household fuels in sub-Saharan Africa, we projected that, between 2000 and 2030, there would be 8.1 million annual premature deaths among children and 1.7 million premature deaths among adult women. However, about a million of these deaths could be avoided by a gradual transition to the use of charcoal, while a more rapid transition could nearly triple the numbers of premature deaths avoided.

Using charcoal costs no more to households than burning wood, as it avoids the infrastructure requirements of other fossil fuels. Charcoal also has a well-established production and marketing network in many countries and can be more easily scaled up than a transition to fossil fuels.

Greater use of charcoal is not without drawbacks: it would result in much higher emissions of greenhouse gases if the wood is harvested unsustainably and made into charcoal in traditional kilns. And charcoal has implications for forest cover, soil fertility, and biodiversity in ways that have not yet been fully studied. But evidence from Latin America and Asia shows that it is possible to produce charcoal in more envi-

ronmentally sustainable ways, particularly through changes in land management to ensure sufficient replacement of trees, the use of alternative feedstocks, and the introduction of highly efficient kilns.

Greater use of other transformed biofuels might also produce significant benefits, although these other fuels have received little attention in the health and indoor air pollution literature. Nonetheless, if the technological, funding, and institutional challenges could be met, transitioning to sustainable fuels like charcoal offers a valuable opportunity to promote gender equality and improve environmental sustainability, while also ranking among one of the most cost-effective health interventions in developing countries.

Further Reading

- Dherani M., D. Pope, M. Mascarenhas, K.R. Smith, M. Weber, and N. Bruce. 2008. Indoor Air Pollution from Unprocessed Solid Fuel Use and Pneumonia Risk in Children Aged under Five Years: A Systematic Review and Meta-Analysis. *Bulletin of the World Health Organization* 86(5): 390–398C.
- Ezzati, M. 2005. Indoor Air Pollution and Health in Developing Countries. *Lancet* 366(9480): 104–106.
- Smith, Kirk R., and Majid Ezzati. 2005. How Environmental Health Risks Change with Development: The Epidemiologic and Environmental Risk Transitions Revisited. *Annual Review of Environmental Resources* 30: 291–333.
- Smith, Kirk R., Sumi Mehta, and Mirjam Maeusezahl-Feuz. 2004. Indoor Air Pollution from Household Use of Solid Fuels. In *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attribution to Selected Major Risk Factors*, edited by M. Ezzati, A.D. Lopez, A. Rodgers, and C.J.L. Murray. Geneva, Switzerland: World Health Organization.