NBER
NATIONAL BUREAU OF ECONOMIC RESEARCH
BULLETIN ON AGING AND HEALTH

Advanced Purchase Commitments for a Malaria Vaccine

Today approximately forty percent of the world's population is at risk of malaria, a life-threatening parasitic disease carried by mosquitoes. Each year, malaria causes over 300 million acute illnesses and one million deaths. Malaria primarily affects individuals in low-income countries — the majority of its victims are young children and pregnant women in sub-Saharan Africa. Children who survive severe cases of malaria may suffer brain damage and learning disabilities, and often become weak and lethargic from the disease later in life.

The scientific challenges in developing an effective malaria vaccine are formidable; nonetheless, many scientists are optimistic. There has also been encouraging news recently with the completion of a phase IIb malaria vaccine clinical trial, although there are many steps before this vaccine or others would be ready for widespread use. However, of primary concern is whether the necessary financial resources will be invested to move this and other candidate malaria vaccines further along in the development pipeline. Pharmaceutical companies may be unwilling to invest in developing a new vaccine or drug for which the affected population is very poor. Companies may also worry that once a product has been developed which is needed in low-income countries, governments and aid institutions will use their power as the primary buyers of the product to keep prices below the level needed for firms to recoup R&D costs.

One possible way to address these concerns is through an "advance purchase commitment." Under this mechanism, credible sponsors such as large foreign aid donors would commit, in advance of a vaccine's development and licensure, to a minimum price that would be paid per person immunized for an eligible product, up to a certain number of individuals immunized. In exchange, firms would commit to produce additional doses in the longer-term at a low price. If no suitable product were developed, no payments would be made. Such a commitment would not eliminate all risk to developers (for example, a vaccine may still fail in clinical trials), but would greatly reduce the uncertainties that are specific to products for low-income country markets and thereby put malaria on a more equal footing with health conditions that affect affluent populations in firms' R&D allocation decisions. The UK Government has expressed support of such a proposal for malaria and HIV vaccines, and the G8 (Group of Eight) countries are exploring the use of such mechanisms.

In **Advanced Purchase Commitments for a Malaria Vaccine: Estimating Costs and Effectiveness** (NBER Working Paper 11288), researchers **Ernst Berndt, Rachel Glennerster, Michael Kremer, Jean Lee, Ruth Levine, Georg Weizsäcker**, and **Heidi Williams** estimate the commitment size necessary to provide a market for a malaria vaccine comparable to the revenue realized from typical existing pharmaceuticals, and discuss the cost-effectiveness of such a program.

The authors first consider reported sales numbers of existing commercial pharmaceutical products. Using data on new chemical entities introduced in the U.S. in the early 1990s, they find that the present value revenue stream derived over the life cycle of the aver-

age product in their sample is $3.44 Billion. Since the authors anticipate that marketing costs would be lower for a malaria vaccine than the typical new pharmaceutical product, they reduce this figure by 10%, to $3.1 Billion.

As a check on this calculation, the authors also derive a commitment size estimate based on estimates from individuals in the biotechnology venture capital industry on what level of revenue is needed to spur substantial R&D investments, and find that this method produces an estimate quite similar to the $3.1 Billion figure. The authors note that because the starting year of purchases under the program is highly uncertain, the commitment should be indexed to account for inflation.

Next, the authors consider the cost-effectiveness of such an advance purchase commitment. As a benchmark for determining cost-effectiveness, they note that health interventions in poor countries that cost about $100 per disability adjusted life year (DALY) saved are generally considered highly effective. Alternatively, the cost-effectiveness of a malaria vaccine could be compared to the cost of purchasing and

delivering the antiretroviral drugs being used to treat AIDS in low-income countries, which are estimated to cost at least $613 per year of treatment.

The authors consider a benchmark malaria vaccine advanced purchase commitment that would guarantee the manufacturer $15 per person for the first 200 million people immunized and set the price of the vaccine at $1 per person thereafter. Such a commitment would generate $3.2 Billion in revenues for the vaccine manufacturer. Under their baseline set of assumptions, they find that such a commitment would cost less than $15 per DALY saved, including vaccine purchase and delivery costs, making it an extremely cost-effective health expenditure.

In their calculations, the authors must make numerous assumptions about vaccine efficacy, delivery costs, countries participating in the program, rate of adoption of the vaccine, and purchases in non-covered countries. In their benchmark calculations, the authors combine these assumptions with data on disease burden and fertility, as well as the distribution of burden of disease by age and gender, in order to calculate the discounted burden of disease that would be averted under this program as well as other figures such as the cost per DALY saved.

The authors then test the sensitivity of their results through varying the baseline assumptions, and also provide a downloadable spreadsheet tool readers can use to vary the assumptions themselves. The sensitivity results suggest that the cost-effectiveness of the vaccine is relatively insensitive to change in assumptions about efficacy, take-up rates, and the price paid for the vaccine, but is more sensitive to changes in the number of vaccine doses and the duration of vaccine protection — suggesting that stipulations regarding the maximum acceptable number of doses and minimum duration of protection for eligibility should be built into the advance purchase contract.

The authors conclude that a commitment of $3.1 Billion may be sufficient to stimulate substantial new investment in the development of a malaria vaccine, yet still be extremely cost-effective from a public health perspective. A larger commitment would be expected to spur more firms to enter the search for a vaccine and result in quicker development. Finally, they note that this same framework could be used to analyze the size and cost-effectiveness of advance purchase commitments for vaccines to prevent other health conditions primarily affecting lower-income countries, such as HIV and tuberculosis.

Would More Physical Education Reduce Youth Overweight?

The prevalence of youth overweight has risen dramatically over the past three decades in the U.S. and now represents an epidemic. Since 1970, the fraction of children that are overweight has nearly quadrupled among 6 to 11 year olds and more than doubled among 12 to 19 year olds. Currently, one in six children aged 6 to 19 is overweight, defined as a body mass index (BMI) above the 95th percentile of the historical BMI distribution. Youth overweight is a major public concern because of its well-documented detrimental effects on physical health, mental health, and health care costs.

One possible contributing factor to the rise in youth overweight is decreased physical education (PE) in schools. For example, the percentage of high school students enrolled in daily PE classes fell from 42% to 28% between 1991 and 2003.

The dual trends of rising youth overweight and declining PE time have led numerous organizations, including the American Academy of Pediatrics and the Secretaries of Education and Health and Human Services, to call for students to spend more time in PE classes. Legislation to increase or reform PE has been introduced in 38 state legislatures this year.

Despite the calls for reform, there is little empirical evidence showing that more time in PE classes helps to reduce youth overweight. This question is examined in a new study by **John Cawley, Chad Meyerhoefer**, and **David Newhouse**, **The Impact of State Physical Education Requirements on Youth Physical Activity and Overweight** (NBER Working Paper 11411).

The authors note that simply comparing the effect of time spent in PE on physical activity or weight is likely to be problematic. For example, PE classes may be electives and students who enjoy physical activity may be more likely to enroll, creating a relationship between PE time and physical activity that is not causal. To address this, the authors use state PE requirements to predict the amount of time students spend in PE and use this predicted measure in their analysis. The data for their analysis is a sample of 37,000 high school students from the 1999-2003 Youth Risk Behavior Surveillance System.

The authors first test whether time spent in PE classes translates into a greater amount of physical activity.

They find that it does, but the effects are small. For example, more than two additional hours per week of PE are required for students to report that there was an additional day during the week that they exercised vigorously for at least 20 minutes or did any strength-building activity. As the authors note, "it appears that little of the time spent in PE classes *that students classify as spent exercising or playing sports* translates into additional days with substantial exercise or strength-building activity."

Next, they explore whether additional PE time affects student weight. They find no detectable impact of PE time on BMI or the probability that the student is overweight or at risk of overweight (above the 95th or 85th percentile of the historical BMI distribution).

The authors note that their findings are consistent with those of a previous study that focused on younger children. Thus they conclude that "the consistent inability to reject the null hypothesis of no effect of PE on student overweight suggests that there is not yet a scientific base for the many recent calls to increase PE in order to prevent or reduce childhood overweight."

The Effect of Report Cards on Medicare HMO Enrollment

In recent years, policy makers and health care leaders have become increasingly focused on improving the quality of the U.S. health care system. One promising mechanism for improving quality is medical report cards. If consumers are told that their health care provider scores well below average on quality measures such as the fraction of patients receiving routine screening tests or overall patient satisfaction, they may switch to another provider. Such behavior will benefit not only the patients who switch but also those who do not if low-quality providers feel compelled to make quality improvements.

In order for medical report cards to improve quality, however, it must be the case that at least some consumers read them and switch providers on that basis. If most learning about the quality of health providers occurs through other mechanisms such as own experience or word-of-mouth, then the value of report cards will be minimal.

In **Do Report Cards Tell Consumers Anything They Don't Already Know? The Case of Medicare HMOs** (NBER Working Paper 11420), **Leemore Dafny** and **David Dranove** examine whether the provision of quality information to forty million Medicare beneficiaries affected their enrollment decisions.

Medicare beneficiaries may choose to enroll either in traditional fee-for-service Medicare or in one of the Medicare HMOs available in their area. The Center for Medicare and Medicaid Services (CMS) collects quality data directly from HMOs as well as through a survey of Medicare beneficiaries. Since 1999, the CMS has mailed a pamphlet, *Medicare & You*, to all beneficiaries on an annual basis. In 1999 and 2000, the pamphlet included quality measures for all HMOs operating in the beneficiary's market area. These measures include the percent of women who had a mammogram in the past two years, the percent reporting that their physicians "always communicate well," and the percent rating their care as the "best possible" (a 10 out of 10).

The key measure in the authors' analysis is the share of Medicare beneficiaries in each county and year that are enrolled in each HMO and in traditional Medicare. Their sample has data for nearly 8,000 such county-plan-year observations during 1994-2002. For each observation, they have the quality measures as reported in *Medicare & You* as well as many characteristics of the plan and market such as the monthly premium, whether the plan has prescription drug coverage, and the average age and education level of the county population. Importantly, they also have several quality measures that were not included in *Medicare & You*, which they use to estimate consumer responses to quality that are generated by market-based learning rather than the report cards.

In their analysis, the authors estimate a model in which each Medicare enrollee selects the insurance plan that offers her the highest utility, choosing among traditional Medicare and all the Medicare HMOs operating in her county. The most convenient way to interpret the results is to simulate how enrollment in a typical market changes over time and in response to the publication of report cards. The authors consider a hypothetic market with three HMOs, each with the average national market share of 2.7 percentage points in 1994. One HMO is of high quality (one standard deviation above the average), while the other two HMOs are of average quality.

The results of this exercise are shown in Figure 1. With market learning only (represented by the solid lines), the market share of the high-quality plan more than doubles over an eight year period, while the market share of the average-quality HMOs and of traditional Medicare decline. The dashed lines show the effect of report cards, which boost the market share of the high-quality plan by an additional 2.2 percentage points. Thus, the effect of the report card is nearly as large as the total effect of market learning over eight years. The authors find that the report card effect is entirely due to beneficiaries' responses to consumer satisfaction scores; other quality measures such as the mammography rate do not affect enrollment.

The authors conclude that Medicare enrollees were switching into higher-quality plans independently of government-issued report cards during this period, but that the distribution of report cards greatly accelerated this trend. They find that the total market share of traditional Medicare fell, but not dramatically, as many of the switchers came from lower-quality HMOs. Finally, the authors suggest that in order to understand the full implications of report cards, it will be necessary to also examine supply-side responses, such as whether providers focus disproportionately on improving measures reported in the report cards and skimp on other quality measures.

Figure 1. Effect of Quality on Predicted Plan Market Shares Over Time
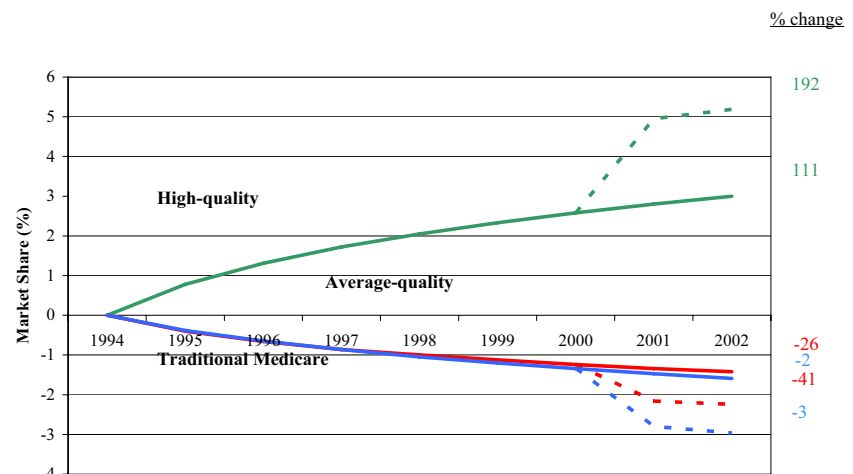
NBER Profile: Joseph P. Newhouse

Joseph P. Newhouse is a Research Associate in the NBER's programs on Health Care, Health Economics, Productivity, and Children.

Newhouse is the John D. MacArthur Professor of Health Policy and Management at Harvard University, as well as the Director of the Division of Health Policy Research and of the Interfaculty Initiative on Health Policy. He is a member of the faculties of the John F. Kennedy School of Government, the Harvard Medical School, the Harvard School of Public Health, and the Faculty of Arts and Sciences at Harvard.

Newhouse is a Fellow of the American Academy of Arts and Sciences and an elected member of the Institute of Medicine. He was the founding editor of the Journal of Health Economics, which he continues to edit, and is a member of the editorial board of The New England Journal of Medicine. He has received the David Kershaw Prize of the Association of Public Policy and Management, the Distinguished Investigator Award of the Association for Health Services Research, the Kenneth J. Arrow award, the Zvi Griliches award, and the Paul A. Samuelson Certificate of Excellence for his writings.

He received a B.A. and Ph.D. in Economics from Harvard University and was a Fulbright scholar in Germany. Prior to joining the Harvard faculty, Newhouse worked for twenty years as an economist at the RAND Corporation.

In the 1970s and 1980s, Newhouse directed the RAND Health Insurance Experiment, which studied the consequences of different ways of financing medical services. Newhouse continues to work on many issues related to health care costs, financing, and quality. His most recent book is Pricing the Priceless: A Health Care Conundrum.

He likes to spend his seemingly non-existent spare time with his two grandchildren, and playing bridge and golf.