The cost-effectiveness of immunization

Peter Cowley & Dean T. Jamison

Immunization is one of the most cost-effective of health interventions.

Over the past four years the World Bank, with a number of collaborators, has undertaken a review of priorities in the health sector. The core of the review is a series of papers on the public health significance of major clusters of diseases in the developing world, and on the cost and effectiveness of currently available technologies for their prevention and case management. The range of diseases studied is extensive, but by no means exhaustive; the results show that cost-effectiveness measures can be potent tools for guiding the health sector on how best to allocate resources and how to determine which of many potentially important interventions should have priority.

As a first step towards setting such priorities from a cost-effectiveness viewpoint, it is necessary to attempt to assess the impact of an intervention in terms of premature mortality, disability or pain, and to weigh this impact against cost. The measure of impact used is Disability-Adjusted Life Years (DALYs), which represent the sum of the years lost from death, and from disability associated with disease and injury. Years of life lost due to premature death at a certain age $x$ are measured by subtracting $x$ from the expected years of life, given a life expectancy at birth of 80 years for men and 82.5 for women. Years lost due to disability are estimated in the same way as mortality, except that the total years are multiplied by a value (less than unity) assigned to the disablement according to its severity. Each of the future years which are lost or are spent disabled are discounted at a cumulative 3% rate per annum back to the present, which makes those years lost in the distant future less valuable than those lost in the near future.

The Health sector priorities review commissioned by the World Bank found that there was a broad range of costs associated with saving a DALY. In fact, those costs varied from under US$ 10 to over $10,000 per DALY saved. The cost-effectiveness of immunization programmes compares favourably with clinic-based programmes and other public health initiatives as expressed in dollars needed to prevent one DALY. Immunization programmes constitute more than one-third of the public health interventions examined whose cost-effectiveness can be estimated at less than $75 per DALY gained.

Immunization costs

The Expanded Programme on Immunization (EPI) on average costs $15 per fully immunized child for the "basic" package. However, these
costs can vary somewhat since they depend on the infrastructure present in a country. These start-up costs often include the technology such as kerosene refrigerators needed for a cold chain in order to keep the vaccines from spoiling. The costs of the cold chain could be kept lower if only we had heat-stable vaccines.

The cost-effectiveness of an EPI-plus programme, which would include immunization with hepatitis and yellow fever vaccines in areas where these diseases are prevalent, would only raise the overall costs by some 25% if both vaccines were given, and would still lead to a cost per DALY gained well below $25. It has been suggested that early childhood immunization programmes could act as vehicles for delivering vitamin-A supplements since vitamin-A deficiency peaks in children aged 2 to 4 years, and using the EPI infrastructure would reduce costs. Furthermore, projections show the yearly costs of vitamin-A supplementation and the cost per DALY gained to be similar to those of one “basic” EPI package.

The geographical distribution of the target population will also affect the cost-effectiveness, as a widely scattered population will require more resources in order for everyone to be reached by an immunization programme. However, these populations often have poor health indicators, including high mortality rates from vaccine-preventable diseases. Thus, any increased resources used for such activities as immunization campaigns can be balanced by increased gains against vaccine-preventable diseases.

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The Product Development Group on Thermostable Oral Poliovaccine has been charged by the CVI with developing vaccines capable of withstanding exposure to a temperature of 45°C for at least seven days without losing their potency, and ensuring their industrial manufacture.

One line of research has already identified several antiviral compounds which can stabilize the antigenic structure of poliovirus for seven days at 42°C, or for three days at 45°C. Another stabilizing system was able to maintain the virus infectivity for seven days at 37°C — still short of the target.

A second approach involving drying of the poliovirus in the presence of a novel carbohydrate, trehalose, produces a vaccine which is completely stable when dried. However, research to overcome the large drop in virus infectivity and vaccine potency is being actively pursued.
vaccine delivery but also on the costs of the vaccine itself and those costs associated with surveillance of the targeted disease in order to monitor the programme’s effectiveness. The costs of the vaccine itself are not overwhelming. The costs of surveillance may vary widely, depending on the epidemiology infrastructure present in the country and the strength of communication between surveillance outposts.

**Future resources saved**

Immunization becomes even more cost-effective in environments where the average annual risk of infection of the targeted disease is high. Even in environments where the average annual risk of infection is low, the cost-effectiveness of immunization may still be apparent; as the average annual risk of infection of the vaccine-preventable disease decreases, the cost of preventing one DALY increases, since the vaccine will be given to large portions of the population who will never have the disease. Although the average annual risk of infection of poliomyelitis is low in the Americas, immunization is still beneficial because it increases the chances of eradication and prefigures the future resources saved in not having to immunize against an already eradicated disease.

Cost-effectiveness can be used to help determine the timing of administration and type of vaccine used in a programme. For instance, in areas where there is a measles epidemic, infants are often vaccinated at as early an age as six months, although the efficacy rate of the measles vaccine at six months is less than that at nine months and often necessitates a two-dose schedule for measles vaccination – one at six months and one at nine months. Nonetheless, this two-dose schedule can still be cost-effective considering the greater proportion of measles cases averted.

Cost-effectiveness data have indicated that the combining of vaccines into a “super vaccine” given at birth would be extremely beneficial. In fact, this is one of the prime directives of the Children’s Vaccine Initiative (CVI). A reduced number of contacts is crucial, since the majority of the costs from any immunization programme stem from the delivery of the vaccine. A reduced number of contacts will also lead to higher coverage rates. Finally, the CVI itself is using cost-effectiveness data to help determine the direction of short-to medium-term research goals by assisting in identifying research costs and potential cost-effective dosing schedules as well as inexpensive heat-stable vaccines.

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Dr Peter Cowley is a Consultant and Mr Dean T. Jamison is the Staff Director at The World Development Report Office, The World Bank, 1818 H Street, N.W., Washington D.C. 20433, USA.