The Economic Benefit of Vaccination

Takamitsu MATSU DAI RA
Director, Japan Pediatric Association

Abstract: To evaluate the economic benefit of vaccination in Japan, five index diseases, i.e., measles, mumps, rubella, chickenpox, and influenza, for which data on related medical care costs and the protection rate and adverse reactions associated with vaccination are available, were chosen from among infectious diseases currently targeted by vaccination in this country. The economic benefit was calculated according to the method proposed by Wiedermann et al. The economic benefit in terms of the benefit cost ratio was highest for the measles vaccine (5.8:1), followed by mumps (2.8:1), rubella (2.0:1), chickenpox (2.6:1), and influenza (1.5:1) vaccines. When the measles vaccination rate is 90%, the economic benefit of this vaccine alone in Japan exceeds 30 billion yen, reflecting the enormous benefit which can be reaped by vaccination overall. Thus, we should be mindful of the tremendous economic benefit of vaccination, as well as its contribution to health.

Key words: Economic benefit; Health care costs; Vaccination costs; Technology assessment

Introduction

Since the enactment of the Preventive Vaccination Law in 1948, the vaccination system in Japan has been effective in preventing the development and spread of infectious diseases and contributing to improvement and progress in the area of public health. The role of vaccination in the prevention of infectious diseases is critical, and many think that the ultimate goal of vaccination, the total eradication of the targeted infectious diseases, might soon be reached.

However, even though these infectious diseases are generally no longer life threatening due to the widespread use of vaccinations, the treatment of infectious diseases still accounts for a large portion of medical care costs in Japan. According to statistics released by the Ministry of Health, Labour and Welfare, even measles, which can be almost completely prevented if scheduled immunizations are properly executed, affects more than 30,000 people in Japan every year, out of which some will die. These figures reflect the complacency with regard to infectious diseases due to the successful widespread use of vaccination. We should however be ever aware of the threat of infectious diseases and appreciate the importance of vaccination.
This paper discusses the benefits of vaccination from the economic viewpoint,1) to provide a deeper understanding of vaccination.

**Method of Calculation and Results**

The index diseases used to evaluate the economic benefit of vaccination in Japan, i.e., measles, mumps, rubella, chickenpox, and influenza, were chosen from among infectious diseases currently targeted by vaccination in this country. Data on related medical care costs and the protection rate and adverse reactions of vaccination are available for measles, mumps, rubella, and chickenpox, while it is possible to determine the effective prevention rate for influenza within a short period of time.

1. **Measles, mumps, rubella, and chickenpox**

   The economic benefit of vaccination was calculated in the same manner as Kamiya et al.,2) according to the method proposed by Wiedermann et al.,3) as shown in Table 1. The health care cost per person (as of June 1, 2000) was calculated by separating direct cost and indirect cost (home care cost), as shown in Table 2.4) The hospitalization rate was determined as 5% for measles, 0.5% for mumps, 0.05% for rubella, and 1% for chickenpox, based on available data.

   The vaccination cost is calculated from the necessary expenditure for vaccination and the cost of treatment for predicted adverse reactions. Specifically, the protection rate of the measles vaccine is estimated to be 97.7%, and the incidence of adverse reactions mainly in the form of fever is estimated to be 20%, which results in at least one visit of the vaccinee to an outpatient clinic. The protection rate of the mumps vaccine is calculated to be 96.2%. Meningitis as an adverse reaction is projected to occur in one out of 10,000 vaccinees. The protection rate of the rubella vaccine is estimated to be 97%, and no adverse reactions requiring treatment are projected. Since about 12% of vaccinees catch chickenpox within 2 years after the chickenpox vaccination, the protection rate of this vaccine is estimated to be 86.7%.

   The outpatient care cost calculated from actual cases is ¥58,802 for measles, ¥19,644 for mumps, ¥17,224 for rubella, and ¥29,572 for chickenpox. Thus, the cost is highest for measles, being 4.2-fold higher than that for rubella.

   The inpatient care cost, also calculated from actual cases, is ¥287,687 for measles, ¥319,775 for mumps, ¥177,688 for rubella, and ¥397,858 for chickenpox. The high figure for chickenpox is attributable to the high cost of subsequent drug treatment.

   The above data were introduced into the equation shown in Table 2. The health care cost per person thus calculated is ¥73,186 for measles, ¥21,243 for mumps, ¥17,313 for rubella, and ¥33,551 for chickenpox; the cost is highest for measles, being 4.2-fold higher than that for rubella.

   The necessary cost for vaccination ($C_v$) was calculated from the equation shown in Table 3. For vaccines which are covered by scheduled immunizations, the necessary cost was calculated based on the individual vaccination fees. The cost of vaccination for vaccines given on a voluntary basis was calculated based on the...
average-rank vaccination fees among pediatric clinics in Tokyo.

The vaccination cost which includes the costs incurred in the treatment of adverse reactions caused by the vaccine, is ¥10,903 for measles, ¥6,710 for mumps ¥7,970 for rubella, and ¥8,500 for chickenpox. Introducing these figures into the equation shown in Table 1, the economic benefit was calculated for each vaccine in terms of the benefit cost ratio (Table 4). The benefit cost ratio is highest for the measles vaccine (5.8:1), followed by the mumps (2.8:1), chickenpox (2.6:1), and rubella (2.0:1) vaccines.

2. Influenza

Unlike the aforementioned four diseases, some reports still raise doubts as to the benefit of the influenza vaccine. These doubts are based on the specific characteristics of the influenza virus. Many researchers do not agree on the economic benefit of influenza vaccine, considering the low protection rate associated with influenza vaccination.

A total of 126 patients were inoculated against influenza at the author’s clinic during the winter of 2000 and they were followed together with a control group of 76 non-vaccinees. During the observation period, 28 (22.2%) of the 126 vaccinees came down with influenza compared to 28 (36.8%) of the 76 non-vaccinees. The incidence of influenza was significantly lower among vaccinees, with a Fisher’s straight line probability of $P = 0.010247$. The effective prevention rate for influenza vaccine was 39.7%, which was higher than the impression obtained from our clinical experience. This gap between perception and observed results arose because vaccinations are apt to be felt ineffective at the scene of clinical practice if effective prevention rates are lower than 50%.

The mean health care cost per patient with influenza, including indirect cost, was ¥76,800, assuming that two days of ambulatory treatment and five days of absence from work are necessary for adult patients. When this figure was introduced into the equation shown in Table 1, the benefit cost ratio of influenza vaccination was 1.5:1, based on the calculation that two inoculations cost ¥6,000. The economic benefit of the influenza vaccine was lower than that of vaccinations for other diseases; this low benefit was attributable to the low protection rate of the influenza vaccine.

### Technology Assessment

On June 20, 2000, the World Health Organization (WHO) announced the results of their assessment of health system performance based on the level of medical service and the general health of people in various countries around the world. Japan ranked first in the world in terms of attainment of health reflected by average life expectancy and the length of a healthy life. However, Japan came in much lower at tenth place in the area of the efficiency of the health system, which reflects the absence of an established health care policy for the efficient use of effective medical technology.

The assessment of medical technology is important in the development of such a policy. This assessment involves determining whether...
the benefit of using medical technology is worth the amount of social resources spent to do so. However, health care policy based on such a technological assessment should include the improvement of the quality of health care as part of its goals, rather than merely keeping down the cost of health care.

The recent Medicaid reform in Oregon in the United States was based on prioritizing health care services, using a cost-benefit analysis technique. The most effective and efficient health care service under this plan is vaccination to children, whereas terminal care and treatment of minor diseases are given a lower priority, casting a new light on the importance of preventive medicine.7)

Conclusion

It is difficult to accurately estimate the benefit of vaccination to society, taking into consideration various factors including the cost of vaccination, adverse reactions to the vaccine, age at disease onset, disease complications, and family structure.

However, an outline of the economic benefit of vaccination could be obtained by calculating the health care cost for spontaneously caught diseases seen in daily clinical practice taking into consideration the protection rate of vaccination. It was thus found that the benefit cost ratio of measles vaccine is the highest (5.8:1), while that of influenza vaccine is the lowest (1.5:1). If the cost for nursing provided by parents and days of absence from work, nurseries/kindergartens, or schools is estimated in a more generous manner in the calculation of the health care cost per person, the economic benefit of vaccination would be even higher.

Kamiya et al. have previously estimated the economic benefit of measles vaccination based on the assumption that the vaccination rate is 90%. They reported that the economic benefit would exceed 30 billion yen. It is certain that the corresponding benefit greatly exceeds this figure now. Considering this, currently implemented vaccination is providing a huge wealth to our country.8) We should take another look at the tremendous economic benefit of vaccination, in addition to its contribution to the health care of the people.

REFERENCES