

Costs and Benefits of Immunization

Immunization is everybody's childhood pain. Many people know that immunization can reduce infections and avoid death. Yet, few people realize that immunization is, of all public health measures, the most cost-benefit investment.

Studies around the world show that immunization is the most direct, most effective, and most economical way of disease prevention. Immunization began in Taiwan in 1948 with the use of diphtheria toxoid. Subsequently, more vaccines such as DPT (diphtheria-pertussis-tetanus combined) , BCG, oral polio vaccine, Japanese encephalitis, measles, and MMR (measles-mumps-rubella combined) have been widely used.

Free immunization though it costs the government NT\$ 450-500 millions each year, due to the decrease rate of infection has brought about tremendous savings in medical care and social costs. Immunization therefore is cost-beneficial. Some cost-benefit analyses of immunization performed in Taiwan and elsewhere are summarized as follows.

The Value of Life

How is life worth? Life is priceless and invaluable. It cannot be measured in terms of money. Other values such as the sorrow of family members, decline in

the quality of life, the cost of caretaker on leave, and the national image cannot be measured in terms of money either.

DPT (Diphtheria-Pertussis-Tetanus)

Immunization of DP T began in Taiwan in 1954. The coverage rate has always been very high. The number of diphtheria cases therefore dropped sharply from 2,186 in 1957 to only one case in 1988. No cases have been reported since 1988 (Figure 1) . The number of tetanus cases also dropped from 1,004 in 1956 to about 10 in 1982 (Figure 2)^(1,2). Pertussis, a threat to infants, has also been brought under effective control.

Poliomyelitis

The pain brought about by poliomyelitis is extremely serious. The number of polio cases in Taiwan reached a peak of 760 in 1958. Salk vaccine was introduced in that year, and Sabin's oral vaccine later in 1966. The number of cases had dropped sharply (Figure 3) . A panicking outbreak in 1982, however, reported 1,043 cases, with 98 deaths. Analysis showed that 66% of the cases had never received the immunization; and 25% had taken only one dose. Complete immunization is most vital. In 1983, Taiwan started the universal use of a yellow card (immunization record) to ensure the completeness and reliability of childhood immunization. No cases of poliomyelitis caused by the wild strain of poliovirus have been reported since 1984. The World Health Organization has made a goal to eradicate poliomyelitis by the year 2000. Taiwan has in fact already eradicated the disease as no confirmed cases have been reported ever since 1992.

BCG

Mortality rate of tuberculosis in Taiwan in 1947 was 294.44 per 100,000 populations. Universal immunization of BCG started in 1965, and the mortality dropped to 7.52 per 100,000 in 1995. Prevalence rate of tuberculosis declined from 5.15% in 1957 to only 0.65% in 1993 1,2) Though studies have concluded that BCG is ineffective in preventing the primary infection of tuberculosis bacillus, it has been proved to be effective in inhibiting the spread of the

bacillus in the human body, and is also considerably effective in preventing tubercular meningitis of children. BCG, therefore, has its value in disease prevention.

Hepatitis B Vaccine

Taiwan has a high infection rate and a high carrier rate of 15-20% for hepatitis B. Hepatitis B is often the cause of chronic hepatitis, liver cirrhosis, and hepatoma. In 1984, Taiwan, became the first country in the world, to begin a nation-wide immunization against hepatitis B. A study in 1996 showed that the carrier rate of hepatitis B of children aged six years has declined from 10.5% to 1.7%. The incidence of child hepatocellular carcinoma has also declined significantly⁽³⁾ (Figure 4)

The incidence of liver cancer of children aged 6-14 has declined yearly; though that of children 0-5 has remained unchanged. The large-scale immunization program has reduced the rates of horizontal and pre- and post-natal infection of hepatitis B, it has directly benefited the younger generation. Reduction in the risks of vertical infection and horizontal infection has also indirectly benefited the older generation. Incidence of liver cancer of children aged 6-14 was zero for the cohorts born in the period between 1986 and 1987. The positive effect of the immunization programs has been recognized internationally, and a new era of vaccines and cancer prevention has begun.

MMR (Measles-Mumps-Rubella)

A program began in 1978 to vaccinate children with one dose of measles vaccine each at ages 9 and 15 months. Measles has been brought under control. A program to eradicate and eliminate poliomyelitis, measles, congenital rubella syndrome, and neonatal tetanus began in 1992. Children were then vaccinated with one dose of MMR at 15 months. In the next three years, all school children, and children under 3rd year junior high were vaccinated with one dose of MMR. No outbreaks of measles, mumps and rubella have been reported in recent years. Reported cases are few, and only a few of them are confirmed.

Children in industrialized countries are often vaccinated with these vaccines. A study in 1988 showed the effect of MMR in France in 1988 showed the number of cases,

complications, sequels and deaths that could be averted in 25 years (Table 1)

Influenza Vaccine

To protect the health of the elderly, to prevent them from an attack of influenza, and thus to save medical costs, Taiwan began to immunize the high-risk elderly of 65 and above who have suffered from cardiac-pulmonary diseases, diabetic patients under medical care, are in long-term care and nursing care institutions, or under home care. A cost-benefit analysis of the program found that the elderly in nursing care institutions had a 54% reduction in hospital admissions due to pneumonia or other cardiac-pulmonary infections, and a 75% reduction in mortality due to pneumonia, complications of influenza, myocardial infarction, and other cardiac-pulmonary diseases⁽⁵⁾

The Effects of EPI (Expanded Program on Immunization)

Some twenty years ago, five million children died each year of measles, tetanus, pertussis, tuberculosis, or poliomyelitis; and millions of children became permanently impaired as a result. In 1974, the World Health Organization started the EPI (Expanded Program on Immunization), and by 1991, more than 80% of the children in the world received immunizations against the above-mentioned infections⁽⁶⁾ The estimate is that the EPI prevents 3.2 million children each year from deaths due to measles, pertussis and neonatal tetanus, and decreases cases of poliomyelitis to 440,000. Yet, each year some 170,000 children worldwide have died of these diseases, and some 120,000 polio cases have occurred. The vaccine costs of the EPI are about US\$ 150,000 million each year. However, costs of vaccines account for a very small part, or less than 10% the total costs of immunization programs⁽⁷⁾.

Benefits of Immunization

Cost-benefit analyses of immunization made in industrialized countries are summarized as follows.

Poliomyelitis

In 1952, there were some 20,000 cases of poliomyelitis in the US. Inactivated poliovirus vaccine (IPV) was used in 1955 to reduce the incidence significantly. In 1961, the US and other countries began to use the live attenuated oral polio vaccine (OPV) to replace IPV. Cost-benefit analyses found that OPV could save 7-14% of costs. A study in West Germany showed that in the period between 1962 and 1971, one German mark spent on OPV immunization alone could have saved 90 German marks 011 medical care and rehabilitation (a 90-fold investment return)⁽⁸⁾

MMR

MMR immunization in France after 25 years showed that the net cumulative benefit of the program was 1.3 billion French francs (Figure 5) . At the beginning, the total costs (social costs incurred by diseases and costs of vaccines) increased. The total cost decreased six years later, and investment returns on immunization came 17 years later. The average return of the immunization program in France was about 4.5% each year⁽⁴⁾

It can be noted from Figure 5 that as far as vaccine manufacturers are concerned, profits from vaccines do not come at once. As a matter of fact, losses are inevitable at the beginning of manufacturing. However, immunization saves lives, and its benefits cannot be measured in terms of profits alone. The government should encourage the manufacturers to invest in the development of new vaccines from this perspective.

Hepatitis B Vaccine

In all hepatitis B immunization programs in industrialized countries, medical care personnel are the priority risk groups for immunization. In Belgium, hepatitis B has been regarded as an occupational disease of medical care personnel and laboratory workers since 1969, and the Fund for Occupational Disease (FOD) has been set up to protect them. The number of this occupational disease began to increase in 1970, and hepatitis B immunization was initiated in 1981. In 1983, the FOD started to pay for hepatitis B immunization. Belgium was the first country to invest in the

prevention of hepatitis B as an occupational hazard, and not as compensation for impairment. Figure 6 shows the number of hepatitis patients compensated by the FOD in the period between 1975 and 1986. The curved line is the projected number of patients that would have been compensated without the immunization program calculated based on the actual number of patients compensated in the period between 1975 and 1980 and their projections. The immunization program implemented by the FOD could have, in the period between 1981 and 1986, prevented 30 cases of chronic hepatitis and liver cirrhosis, and four deaths. The impact of the program on the finance of the FOD is shown in Table 2. The net profit of Belgium francs 40 millions was the savings alone from compensations of the FOD. Savings from medical insurance and from gains of employers from reduction in absenteeism of employees were not included⁽⁹⁾

A cost-benefit analysis conducted upon the request of the US CDC showed that the total costs of the US hepatitis B immunization program of infants were US\$ 105 millions each year. Of which, 62 million was spent on screening and immunization. Without this program, the direct expenditures would have been US\$ 72 million each year, though the indirect costs of losses in productivity that followed would have been 300 million. Though the immunization program did not save much in expenditures, the health benefits that the program brought to were considerable⁽¹⁰⁾

Two factors have a strong impact on the cost-benefit of the infant hepatitis B immunization program. One is the cost of the vaccines, and the other, the prevalence of the infection. In the US, the prevalence of hepatitis B is 0.2%, though it is as high as 15% for some specific ethnic groups. Studies have shown that only when the prevalence reaches the 0.9% level, is the immunization program cost-beneficial. Since Taiwan has a high hepatitis B prevalence of 15- 20%, the cost-benefit of the program can be substantial⁽⁷⁾

Hepatitis B is a serious problem in developing countries, resulting in some one to two million deaths each year. The World Health Organization has thus recommended including hepatitis B immunization in the EPI.

Influenza Vaccines

The medical costs of hospital care in the National Health Insurance Program, one can quantify the direct costs of hospital care, and thus study the cost-benefit of influenza vaccination. The preliminary findings showed that the medical costs of hospital care for pneumonia or other cardiac-pulmonary infections of the elderly who had been immunized against influenza were lower than those of the elderly who had not been immunized. An estimate of the savings in hospital care costs after immunization showed that when the immunization coverage rate of the elderly in the high risk groups reached more than 80%, some NT\$ 575 million in hospital care costs could have been saved. Other unquantifiable costs such as cost of life, quality of life, and caretaker on leave were not included in the estimate. The estimate should be rather conservative and lower⁽⁵⁾

Considerations on the Costs of Immunization Strategies

A study conducted in Thailand in 1987 showed that the cost for a complete immunization schedule for a child ranged from US\$ 5.3 to US\$ 33.2, depending on the frequency of visits a child is required to make. In Thailand, children must visit health centers many times to complete the immunization schedule, the costs therefore, is higher. By reducing the frequency of visits to healthcare institutions, and allowing health workers to allocate their working hours more effectively, the costs of immunization may be reduced⁽¹⁾

Another study conducted in Ecuador in 1986 found that the cost of a complete immunization schedule provided through routine immunization services by fixed institutions was US\$ 4.39 per child; and the cost of such service provided through large-scale special immunization activities was US\$ 8.6 per child. The study also found that although the cost of immunization provided through large-scale special activities was higher, a higher coverage rate could be attained through these activities⁽¹²⁾

The safety and effect of vaccines are more relevant to the use of pertussis vaccines, for they carry the risk of inducing cerebral disorders and other

adverse reactions. A cost-benefit analysis of pertussis vaccines conducted in 1984 gave a benefit to cost ratio of 11:1. The increasing concerns of the mass media of the vaccines, and the increasing lawsuits against them in the US have forced manufacturers to raise the price of the vaccines to meet the suddenly increasing insurance costs. A re-assessment of the vaccines in 1985 found that the per dose cost of DTP was US\$ 2.68, as compared to only US\$ 0.11 in 1984. The risks of inducing cerebral disorders was considered higher than before. The benefit to cost ratio was decided to be 1.1:1. Later, the US revenue system regulated the establishment of a vaccine hazard compensation fund. This decision further increased the costs of vaccines. Although the health benefits brought about by the vaccines are substantial, the benefit to cost ratio has declined to less than one, some countries have decided to replace the DTP vaccines previously in use with DTPa vaccines that are less likely to induce adverse reactions⁽⁸⁾

Conclusion

Studies around the world and the assessment of the influenza vaccines conducted in Taiwan all indicate that immunization can reduce incidence and mortality of diseases, and save a large amount of direct medical care costs and indirect social costs. Immunization is thus considered cost-beneficial. Therefore, to promote the health of the people, in addition to the routine immunizations already in practice, other vaccines that have been proved effective in developed countries such as Haemophilus influenza type b, chickenpox, DTPa, influenza vaccines for the elderly, and vaccines against pneumonia should be introduced in and added to the routine free immunization schedules. This expansion is necessary, economical, and is the future direction of the EPI.

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Figure 1. Cost-Benefit of Diphtheria Vaccines

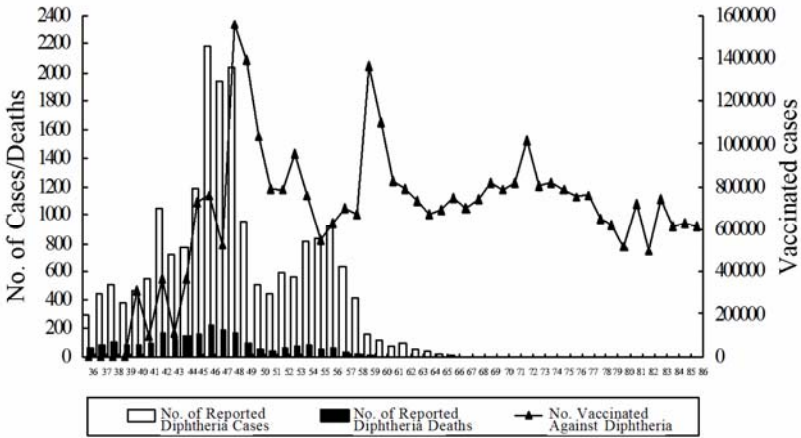


Figure 2. Cost-Benefit of Tetanus Vaccines

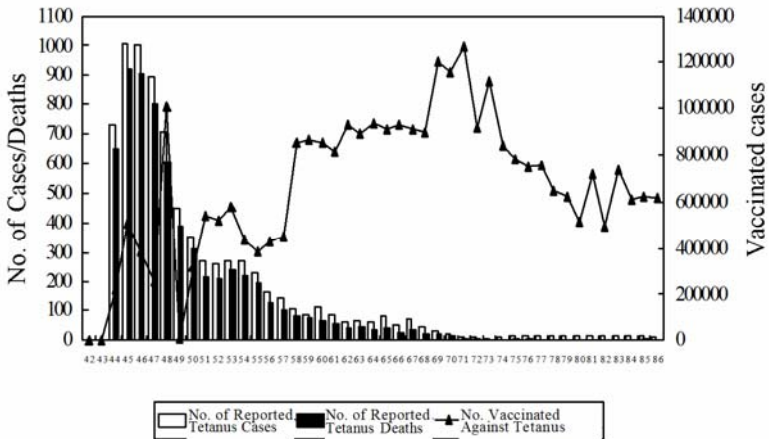
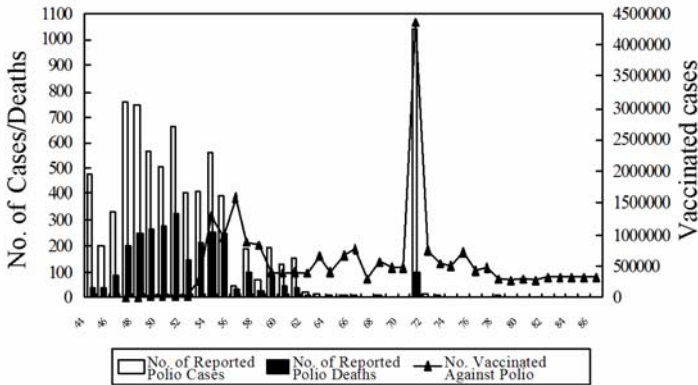
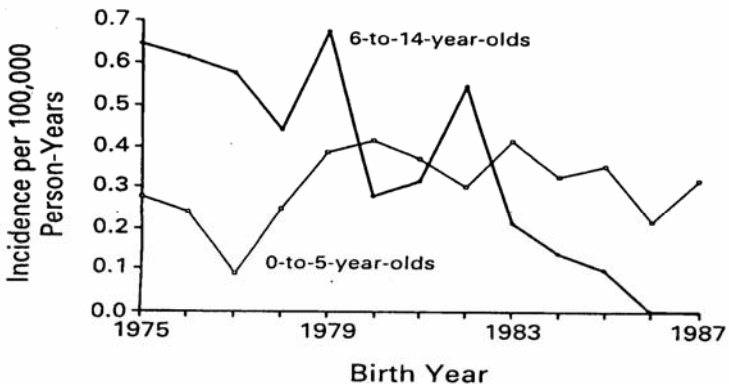


Figure 3. Cost-Benefit of Poliomyelitis Vaccines



Notes: The person-times of children vaccinated in years before 1989 are the sum of the total doses of vaccines used.
 The person-times of children vaccinated in years after 1989 are the sum of those who have completed the three doses

Figure 4. Incidence of Hepatoma of Children Aged 0-5 and 6-14 by Birth Cohorts



Source : Mei-Hwei Chang, et al. N Engl J Med 1997;336:1858

Source: Mei-Hwei Chang, et al. N Engl J Med 1997;336:1858

Figure 5. Changes in 25 Years in the Net Cumulative Benefits of MMR Immunization in France

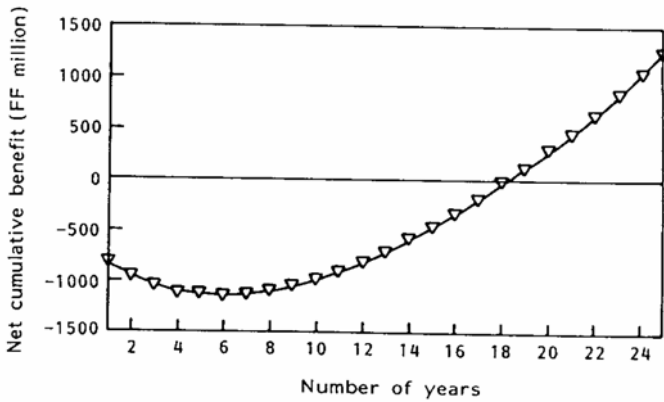


Figure 6. No. of Cases Compensated for Hepatitis B by the Belgium FOD, 1975-1986

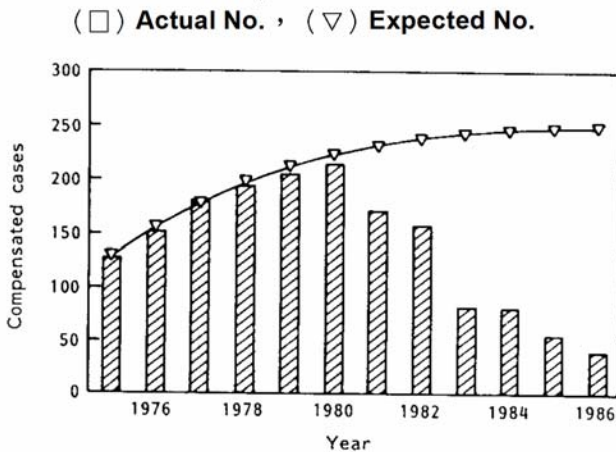


Table 1. Achievements of the MMR Immunization Program in France in 25 Years

	No. of Cases Reduced	No. of Complications Reduced	No. of Sequels Reduced	No. of Deaths Reduced
Measles	9,000,000	2,000	900	500
Mumps	8,000,000	Encephalitis 25,000 Meningococcal meningitis 1,680 Encephalitis		
Rubella	Not calculated		500~3,000	

Source : WHO Weekly Epidemiological Record, 1992

Table 2. Costs of Hepatitis B Vaccines and Savings in Expenditures by the Belgium FOD, 1981 – 1986

FB million	
Costs of Vaccines	160
Savings :	
Temporary impairment	173
Permanent impairment	26
Payments for deaths	2
Total savings	41