Cost-benefit analysis of routine childhood vaccination against chickenpox in Taiwan: decision from different perspectives

Hsu H-C, Lin R S, Tung T H, Chen T H

Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The launch of a mass varicella programme was investigated.

Type of intervention
Primary prevention.

Economic study type
Cost-benefit analysis.

Study population
The study population comprised a hypothetical cohort of 300,000 people aged between 0 and 20 years old.

Setting
The setting was the community. The economic analysis was carried out in Taiwan.

Dates to which data relate
The effectiveness data were derived from studies dating from 1994 to 1996. Resource use and indirect costs were derived from a cross-sectional survey conducted between October 2000 and February 2001. The price year was not reported.

Source of effectiveness data
The effectiveness data were derived from a review of completed studies.

Modelling
A decision analysis using a Markov decision model was constructed to compare varicella vaccination with no vaccination. In the non-vaccinated group, individuals followed the disease natural history. People who were infected with chickenpox might or might not develop into symptomatic cases after the 2-week incubation period. Of the symptomatic cases, patients could suffer from mild or severe complications. Those with the milder form of the disease could undergo four possible scenarios:

- an emergency department visit, whereby medical care within the first 24 hours was sought;
- emergency department visits together with subsequent outpatient visits;
- outpatient visits; and
outpatient visit plus the purchase of over-the-counter medicine.

Severe complications were defined as those requiring hospitalisation, including, but not limited to, pneumonia or encephalitis. Patients with major complications could go on to have no long-term sequelae, long-term disability, or death.

**Outcomes assessed in the review**
The outcomes assessed were as follows.

The age-specific annual incidence rate of varicella in different age groups of the study population.

The probability of varicella sequelae. This included the probability of major complications requiring hospitalisation from varicella, the probability of contracting pneumonia due to varicella, the probability of contracting encephalitis due to varicella, the probability of dying due to varicella, and the probability of a long-term disability after encephalitis.

The parameters of vaccine efficacy. These included the probability of complete protection after vaccination, the probability of partial immunity by the age of 20 years, the relative susceptibility to varicella, the relative infectiousness, and the relative probability of major sequelae.

The vaccination complication rate.

The asymptotic rate.

The coverage rate.

**Study designs and other criteria for inclusion in the review**
Not stated.

**Sources searched to identify primary studies**
Not stated.

**Criteria used to ensure the validity of primary studies**
Not reported.

**Methods used to judge relevance and validity, and for extracting data**
Not reported.

**Number of primary studies included**
Four studies were included in the review.

**Methods of combining primary studies**
The age-specific annual incidence rate of varicella was derived from two different studies. However, the authors did not report how the results from these two studies were combined.

**Investigation of differences between primary studies**
The authors reported that the studies included in the review accounted for heterogeneity in the risk of transmission and contraction of infection according to the individual's age group.
Results of the review
The annual age-specific incidence rate of varicella was 0.05 for 0- to 1-year-olds, 0.03 for 2- to 3-year-olds, 0.16 for 3- to 5-year-olds, 0.13 for 5- to 7-year-olds, 0.22 for 7- to 11-year-olds, 0.01 for 11- to 15-year-olds, and 0.04 for 15- to 20-year-olds.

The probabilities of varicella sequelae were as follows:

the probability of major complications requiring hospitalisation from varicella was 0.0045,

the probability of contracting pneumonia due to varicella was 0.00014,

the probability of contracting encephalitis due to varicella was 0.00014,

the probability of dying due to varicella was 0.0000082, and

the probability of a long-term disability after encephalitis was 0.00000042.

The vaccine efficacy parameters were as follows:

the probability of complete protection after vaccination was 0.95,

the probability of partial immunity by the age of 20 years was 0.22,

the relative susceptibility to varicella was 0.12,

the relative infectiousness was 0.4, and

the relative probability of major sequelae was 0.01.

The vaccination complication rate was 0.02.

The asymptotic rate was 0.1.

The coverage rate was 0.95.

Measure of benefits used in the economic analysis
The measure of benefits used was the monetary benefits. Valuation of the vaccination programme was then carried out using a willingness-to-pay (WTP) approach. A cross-sectional survey was conducted to interview a total of 188 varicella cases, which were sampled from local general practitioners and paediatricians. The estimate of WTP was then measured by asking the following question: "What is the most that you would be willing to pay for routine varicella vaccination programme that reduces the risk of death and long-term disability as shown in table 1?". Of the 188 interviewees, only 178 (94%) completed the interview.

Direct costs
The costs and the quantities were reported separately. The direct costs included in the analysis were those of the health care system and the patient. These related to the outpatient department, hospitalisation, emergency visits, over-the-counter drugs and long-term disability. The direct costs also included out-of-pocket expenses. Since varicella vaccine was administered with the measles-mumps-rubella vaccine in the authors' setting, there were no additional physician consultation fees and costs for varicella vaccine administration. With the exception of hospitalisation rate and long-term disability rate, which were derived from a published study, the resource use data for these services were derived from a cross-sectional survey of 188 varicella cases, of which only 178 (94%) completed the interview. The unit costs were obtained from data provided by the National Health Insurance. Discounting was relevant since the costs were incurred during more than two years, and was appropriately performed using an annual rate of 5%. The study reported both the total and incremental costs. The price year was not reported.
**Statistical analysis of costs**
Resource use and costs were treated as point estimates (i.e. the data were deterministic).

**Indirect Costs**
The authors included indirect costs in the analysis. These related to the productivity losses of parents who could not work due to caring for the patient, accompanying the child to visit the doctor and staying with the child during hospitalisation, and the productivity losses due to early death and long-term disability due to varicella. The capital approach was applied to calculate the cost of work loss by multiplying each adult’s loss of working days by the daily income. The survey used to collect information on WTP and resource use also collected information on the days off work taken by parents (or other family members) to care for the child, and the monthly incomes of parents or families who could not work due to caring for a patient. The death rate and long-term disability were derived from a published study. Discounting was relevant since the costs were incurred during more than two years, and was appropriately performed using an annual rate of 5%. The study reported both the total and incremental costs. The price year was not reported.

**Currency**
New Taiwan dollars (NTD).

**Sensitivity analysis**
A series of one-way sensitivity analyses were conducted to examine the uncertainty in the published and unpublished data. The key model variables included the annual attack rate, the asymptotic rate, the coverage rate, the discounting rate, the vaccine efficacy rate and the herd immunity effect. Also, the mild disease rate in vaccinee, the adverse rate after vaccination, the severe disease rate in vaccinee, the vaccine cost, and the symptomatic rate of vaccinee.

**Estimated benefits used in the economic analysis**
The average estimate of the WTP to reduce major sequelae was NTD 729. Translating this figure into a benefit yielded a benefit of NTD 220 million due to the vaccination programme.

**Cost results**
From the health care payer’s perspective, the discounted cost of the non-vaccination programme was NTD 203 million, while that of the vaccination programme was NTD 484 million. Hence, the discounted net cost for the vaccination programme was NTD 281 million.

From the societal perspective, the discounted cost of the non-vaccination programme was NTD 944 million, while that of the vaccination programme was NTD 492 million. Hence, the discounted net saving for the vaccination programme was NTD 452 million.

The authors also calculated benefit-to-cost ratios as the reduction in disease costs divided by the cost of the vaccination programme. This ratio was 0.34 (save NTD 0.34 in discounted costs for each NTD incurred in a vaccination programme) when using the payer’s perspective and 2.06 when using the societal perspective.

**Synthesis of costs and benefits**
The costs and benefits were combined using the net benefit. The authors estimated the net present value of the programme, taking the indirect cost into account, to be -NTD 272 million (i.e. the total benefit as calculated by the WTP method, NTD 220 million, minus the total cost for the vaccination programme, NTD 492 million).

The cost-effectiveness of the programme was highly sensitive to vaccine price and insensitive to vaccine efficacy.
Authors' conclusions
A routine varicella vaccination programme was worthwhile from the societal perspective, but not from either the health care payer's perspective or from consumer decision based on the perspective of willingness-to-pay (WTP), owing to the net present value of the programme being negative.

CRD COMMENTARY - Selection of comparators
A justification was given for using no vaccination as the comparator. Taiwan had not yet included mass vaccination against chickenpox under the state-run childhood immunisation schedule. You should decide if the comparator represents current practice in your own setting.

Validity of estimate of measure of effectiveness
The authors did not state that a systematic review of the literature was undertaken to identify relevant research and minimise bias. The authors also did not report the sources searched, or the inclusion criteria of their review. It was not reported how the results from two studies were combined to derive the age-specific incidence of varicella. However, the authors reported that the studies used to derive estimates of effectiveness accounted for heterogeneity in the risk of transmission and contraction of infection according to the individual's age group. The authors also carried out a sensitivity analysis to examine uncertainty in the data, using ranges that appear to have been appropriate.

Validity of estimate of measure of benefit
The WTP was elicited from a cross-sectional survey conducted in a total of 188 people who had suffered from varicella. The benefits were appropriately discounted at a rate of 5% per annum.

Validity of estimate of costs
All the categories of cost relevant to the perspective adopted were included in the analysis. The authors did not include the administration costs of varicella vaccination as they reported that, in their setting, the vaccine would be administered with the measles-mumps-rubella vaccine. The costs and the quantities were reported separately. The resource use quantities were derived from both a published study and a cross-sectional survey of 188 individuals who had suffered from varicella. The authors do not appear to have performed sensitivity or statistical analyses on resource use. Hence, the uncertainty in the results was not examined. Examining the uncertainty in these estimates is important because of the possible recall bias involved when patients are asked about their resource use in health care over a period of time. The prices were derived from the National Health Insurance. Vaccine costs were varied in the sensitivity analysis, using range that appear to have been appropriate. Discounting was necessary since all the costs were incurred during more than two years, and was performed at an annual rate of 5%. The date to which the prices related was not reported, which will hamper any possible inflation exercises.

Other issues
The authors made appropriate comparisons of their findings with those from other studies that found benefit-to-cost ratios higher than those reported in this study. According to the authors, differences in the ratios could stem from the fact that annual attack rates adopted in the study were age-specific and may be lower than other studies, or because of different study designs and different medical usage in the treatment of varicella across countries. The issue of generalisability to other settings was partly addressed in the sensitivity analysis. The authors do not appear to have presented their results selectively, and their conclusions reflected the scope of the analysis. However, the way in which the authors calculated the net benefit unclear. When the benefits and costs were combined, the authors did not undertake an incremental approach. Hence, the costs of the non-vaccination programme were not included. If these had been included, the net present value of the programme would have yielded benefits of around NTD 672 million.

The authors reported a number of further limitations to their study. First, not all possible long-term effects of varicella vaccination were considered, owing to its complexity. Second, the results were conditional on achieving a coverage rate of 95% and being administered with the measles-mumps-rubella vaccine. Finally, the authors did not attempt to include the potential benefits or costs of future cases of zoster.
Implications of the study
The authors appear to recommend the introduction of a routine varicella vaccination programme, as they reported that it was worthwhile from the societal perspective.

Source of funding
None stated.

Bibliographic details

PubMedID
12922134

Other publications of related interest


Indexing Status
Subject indexing assigned by NLM

MeSH
Chickenpox /economics /prevention & control; Chickenpox Vaccine /economics /therapeutic use; Child; Cost of Illness; Cost-Benefit Analysis; Decision Support Techniques; Humans; Immunization Programs /economics; Markov Chains; Mass Vaccination /economics; Taiwan

AccessionNumber
22003008552

Date bibliographic record published
30/11/2004

Date abstract record published
30/11/2004