Estimating the potential cost-effectiveness of using *Haemophilus influenzae* type b (Hib) vaccine

Field test version 1
Contents

Acknowledgements ......................................................................................................... iv

Introduction ................................................................................................................... 1

Estimating costs of vaccine and its administration ...................................................... 1

Estimating treatment costs averted as a result of immunization ............................... 3

Estimating net costs of introducing Hib vaccine ......................................................... 5

Estimating the cost-effectiveness of introducing the vaccine ..................................... 5
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Introduction

Cost-effectiveness estimates of using conjugate Hib vaccine in a childhood immunization schedule can be generated by combining burden estimates with cost data.

For an analysis from the perspective of the health sector, two types of cost data should be available:

1) Costs of vaccine and its administration.
2) Treatment costs averted as a result of immunization.

If looking at a societal perspective, time and other costs incurred by parents due to illness of the child and taking the child for vaccination should be included as well. However, this data is difficult to collect and for this reason it is recommended that the analysis be limited to the health sector perspective.

Estimating costs of vaccine and its administration

The cost of vaccine administration depends on whether a monovalent or combination vaccine will be used. While the price of a combination vaccine is higher than a monovalent vaccine, it will not involve any additional injections and is therefore more simple to introduce. If the combination vaccine is procured in the same vial size as used for the non-Hib components already in use the vaccine will not use any additional space in the distribution system. If the vaccine on the other hand is a monovalent vaccine, or if the combined vaccine is introduced with fewer doses per vial than previously used in order to reduce wastage, the vaccine will use more space in the distribution system and this may then call for expansion of the space required in the system.

In the following, it is explained how to assess the most important cost items involved with introduction of a new vaccine - namely vaccines, syringes, safety boxes, waste management and expansion of the distribution system. Other resource inputs, such as increased disease surveillance and training is likely to be needed with the introduction but could be excluded from a rapid assessment.

a) Vaccine costs

Total vaccine costs per year, c, is estimated as:

\[ c = p \times n \]

where

- \( p \) = Price per dose of new vaccine, including freight expenses
- \( n \) = Number of doses supplied
Number of doses supplied for the first year, $n$, are estimated as:

$$n = c \times b \times d \times \left(\frac{1}{1-w}\right) \times (1 + r)$$

where,

- $c$ = immunization coverage rate
- $b$ = birth cohort
- $d$ = no. of doses per fully immunized child
- $w$ = wastage rate (in per cent)
- $r$ = reserve stock (in per cent)

When estimating the number of doses needed for subsequent years, the same formula should be used, with the exception of the reserve stock which should be excluded. That is:

$$n = c \times b \times d \times \left(\frac{1}{1-w}\right)$$

It should be remembered that if a combination vaccine is introduced, the annual costs of the vaccine already being used, but which will be replaced by the combination vaccine, should be subtracted from the total costs figure so that an estimate of only additional costs is provided.

**b) Costs of syringes, safety boxes and waste management**

If the new vaccine is introduced as a monovalent vaccine, extra syringes per fully immunized child are needed. Total annual syringe costs, $c$, are estimated as:

$$c = p \times s$$

where

- $p$ = price per syringe, including freight expenses
- $s$ = annual number of syringes needed

For the first year, $s$ is estimated as:

$$s = n \times \left(\frac{1}{1-w}\right) \times (1+r)$$

where

- $n$ = number of injections administered per year
- $w$ = wastage rate (in per cent)
- $r$ = reserve stock (in per cent)
Estimation of the annual number of injections administered, \( n \), is estimated as:

\[
n = c \times b \times d
\]

where

- \( c \) = coverage rate
- \( b \) = birth cohort
- \( d \) = no. of doses per fully immunized child

It is important to include the costs of safety boxes and waste management as part of the delivery costs. A detailed explanation for estimating these costs is explained in the WHO document ‘Estimating costs for budgeting and cost-effectiveness analysis related to new vaccine introduction’ (WHO 2001). Alternatively, as a rule of thumb, this cost can be estimated as 20% of syringe costs.

c) Estimating the costs of expanding the distribution system

If the vaccine is introduced as a monovalent vaccine, it is important to assess whether there is enough space in the distribution system to accommodate it. If not, the space of the system must be expanded. The WHO has developed a "Vaccine volume calculator" to assess the percentage increase in storage space needed for introducing a new vaccine. This calculator can be accessed on the internet (www.who.int/vaccines-documents/). When the percentage increase has been calculated, immunization services managers should be consulted about whether the additional storage space needed will be available in the present system. If this is not the case, costs of expanding the system should be estimated in terms of transport and cold storage.

Estimating treatment costs averted as a result of immunization

A full cost of illness study involves collecting resource utilization data and unit costs from many different health care providers. This is a time consuming activity. For a less detailed estimate of the costs of treating Hib meningitis and pneumonia, within the timeframe of the assessment, the approach outlined below is recommended.

a) Estimating the costs of treating Hib meningitis

Two steps are involved when estimating the total costs of treating meningitis per year on a national basis. First, the average cost of treating a meningitis case in the facilities visited should be estimated. Secondly, this estimate should be applied to the number of cases predicted to be treated in this type of facility in the country per year.

(i) Estimating the average costs of treating a Hib meningitis case

The total costs of treating a Hib meningitis case in hospital should be estimated by adding the costs of pharmaceuticals, diagnostic tests, specialized services and "hotel costs" for staying in the hospital, both in a paediatric ward and in an intensive care unit (ICU).
However, detailed cost data on these different resources are not readily available in most hospitals of the developing world. For a rough estimate it is therefore recommended to use the average costs of an inpatient day in the paediatric ward as well as in the ICU. An estimate of this cost should be available from most hospitals. When using the figure provided it should be checked whether the cost estimate includes pharmaceuticals, diagnostic tests, etc., or whether it only represent the costs of “hotel”. If it is only the hotel costs, an estimate of the average costs of pharmaceuticals, procedures etc. must be calculated and added to the average costs per inpatient day.

Total costs of treating a meningitis case in hospital should be estimated as:

$$C_p \times N_p + C_{ICU} \times N_{ICU}$$

where

- $C_p$ = Average cost per inpatient day in paediatric ward
- $N_p$ = Average number of days of stay in paediatric ward
- $C_{ICU}$ = Average cost per inpatient day in ICU
- $N_{ICU}$ = Average number of days of stay in ICU

(ii) **Estimating the total costs of treating all Hib meningitis**

The average cost estimate calculated using the method described above should be applied to the predicted number of cases per year occurring in the country. An overall estimate of total costs can be calculated by simply multiplying the average costs with the annual number of estimated Hib meningitis cases. This estimate will however not represent the true cost figure for two reasons. First, different hospitals operate in different ways with regard to treatment procedures and length of stay, and average costs therefore vary considerably. Secondly, in many countries a part of the population have no easy access to tertiary health services and it is therefore likely that cases do not reach a hospital. Hence, treatment costs are less for these cases. It is recommended that these conditions be taken into account when making assessments and that the evaluation be used to adjust the overall cost estimate or at least presented along with the result. An adjustment could for instance be made by assuming that a certain percent of Hib meningitis cases reach a hospital.

b) **Estimating the costs of treating Hib pneumonia**

As in the case of meningitis, two steps are involved. First, an average estimate of treating a Hib pneumonia case should be calculated and this figure should then be applied to the estimated number of cases per year. However, as the severity of pneumonia varies considerably in a population it is difficult to arrive at an average cost estimate. Recognizing that a large proportion of pneumonia cases are not severe, and are therefore treated in outpatient clinics and not in hospitals, cost estimates based only on hospitalized cases will overestimate the true costs.
(i) Estimating the costs of treating a pneumonia case in hospital
For estimating the costs of treating a pneumonia case in hospital, the same method of calculation as for H ib meningitis explained above should be used. How ever, it is not likely that pneumonia cases will make use of an ICU. Instead costs per inpatient day consists of pharmaceuticals, diagnostic tests, oxygen supply and “hotel” stay. An average cost estimate should be generated.

(ii) Estimating total costs of treating all pneumonia cases
It is recommended that only hospitalized cases are included in the analysis. Estimation of cases being treated in outpatient facilities is beyond the scope of the assessment. Hence, for an overall estimate the proportion of pneumonia cases being treated in hospital should be assessed and this number should be multiplied with the average cost per patient.

Estimating net costs of introducing H ib vaccine
The net costs of introducing the vaccine is calculated as follows:

\[ C = C_v - (T_m + T_p) \]

where

\[ C = \text{Annual net costs} \]
\[ C_v = \text{Annual costs of vaccine and its administration} \]
\[ T_m = \text{Annual costs of treating H ib meningitis} \]
\[ T_p = \text{Annual costs of treating H ib pneumonia} \]

Estimating the cost-effectiveness of introducing the vaccine
By combining the net costs with the burden estimates, the following cost-effectiveness ratios can be calculated:

Cost per H ib meningitis case prevented
Cost per H ib meningitis death prevented
Cost per H ib pneumonia case prevented
Cost per H ib pneumonia death prevented
Cost per H ib case prevented
Cost per H ib death averted