

RESOURCE FROM:

**Evaluating HPV vaccination pilots:**  
PRACTICAL EXPERIENCE FROM PATH

PUBLICATION TITLE

# Guidelines for Estimating Costs of Introducing New Vaccines into the National Immunization System

PUBLISHER

WHO

PUBLICATION DATE

2002

This document is available online at:  
[www.rho.org/hpv-evaluating-pilots.htm](http://www.rho.org/hpv-evaluating-pilots.htm)

# Guidelines for estimating costs of introducing new vaccines into the national immunization system



**DEPARTMENT OF VACCINES  
AND BIOLOGICALS**



*World Health Organization  
Geneva  
2002*

---

**The Department of Vaccines and Biologicals  
thanks the donors whose unspecified financial support  
has made the production of this document possible.**

This document was produced by the  
Vaccine Assessment and Monitoring Team  
of the Department of Vaccines and Biologicals

*Ordering code: WHO/V&B/02.11*

*Printed: June 2002*

**This document is available on the Internet at:**

[www.who.int/vaccines-documents/](http://www.who.int/vaccines-documents/)

**Copies may be requested from:**

World Health Organization

Department of Vaccines and Biologicals

CH-1211 Geneva 27, Switzerland

• Fax: + 41 22 791 4227 • Email: [vaccines@who.int](mailto:vaccines@who.int) •

© World Health Organization 2002

All rights reserved. Publications of the World Health Organization can be obtained from Marketing and Dissemination, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel.: +41 22 791 2476; fax: +41 22 791 4857; email: [bookorders@who.int](mailto:bookorders@who.int)). Requests for permission to reproduce or translate WHO publications – whether for sale or for noncommercial distribution – should be addressed to Publications, at the above address (fax: +41 22 791 4806; email: [permissions@who.int](mailto:permissions@who.int)).

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

The World Health Organization does not warrant that the information contained in this publication is complete and correct and shall not be liable for any damages incurred as a result of its use.

---

# Contents

<i>Abbreviations</i> .....	v
<i>Glossary</i> .....	vii
<i>Preface</i> .....	ix
<b>1. Introduction</b> .....	<b>1</b>
<b>2. Concepts of cost analysis</b> .....	<b>2</b>
2.1 Incremental versus full costs .....	2
2.2 Financial versus economic costs .....	2
2.3 Capital versus recurrent costs .....	3
<b>3. How to identify and estimate costs</b> .....	<b>4</b>
<b>4. Vaccine supplies</b> .....	<b>6</b>
4.1 Vaccines .....	6
4.2 Injection syringes.....	9
4.3 Reconstitution syringes.....	10
4.4 Safety boxes.....	11
<b>5. Waste management</b> .....	<b>12</b>
<b>6. Distribution system</b> .....	<b>13</b>
6.1 Transportation of vaccines .....	13
6.2 Cold storage .....	14
6.3 Storage and transportation of injection equipment and waste management supplies .....	14
<b>7. Personnel</b> .....	<b>16</b>
<b>8. Surveillance and monitoring</b> .....	<b>17</b>
8.1 Stationery .....	17
<b>9. Other costs</b> .....	<b>18</b>
9.1 Social mobilization .....	18
9.2 Training .....	18
<b>10. Presenting and analysing results</b> .....	<b>19</b>

---

<b>Bibliography .....</b>	<b>21</b>
<b>Annex 1: New and underused vaccines and vaccines under development (as of late 2001) .....</b>	<b>22</b>
<b>Annex 2: Annualization of capital costs .....</b>	<b>24</b>
<b>Annex 3: Calculating packed volume for transport.....</b>	<b>27</b>
<b>Annex 4: Calculating vaccine volume for cold storage .....</b>	<b>30</b>
<b>Annex 5: Vaccine storage volumes, including primary packing (October 2001) .....</b>	<b>34</b>
<b>Annex 6: Budget line items for disease surveillance .....</b>	<b>36</b>
<b>Annex 7: Using results in cost-effectiveness analysis .....</b>	<b>37</b>
<b>Annex 8: Forms for data collection .....</b>	<b>38</b>

---

# Abbreviations

AD	auto-disable (syringe)
BCG	bacillus Calmette-Guérin (vaccine)
DT	diphtheria-tetanus (vaccine)
DTP	diphtheria-tetanus-pertussis (vaccine)
EPI	Expanded Programme on Immunization
FIC	fully immunized child
HepB	hepatitis B (vaccine)
Hib	<i>Haemophilus influenzae</i> type b (vaccine)
MMR	measles-mumps-rubella (vaccine)
MR	measles-rubella (vaccine)
OMV	outer membrane vesicle
Td	tetanus-diphtheria (vaccine)
TT	tetanus toxoid (vaccine)
UNICEF	United Nations Children's Fund
VVM	vaccine vial monitor



---

# Glossary

Auto-disable syringe	A specially modified disposable syringe with a fixed needle that is automatically disabled by plunger-blocking after it has been used once.
Cold chain	A network of refrigerators, cold stores, freezers and cold boxes organized and maintained so that vaccine is kept at the right temperature to remain potent between dispatch from the manufacturer and administration.
Cold store	A cold room or freezer room.
Combination vaccine	A vaccine made by combining two or more vaccines.
Diluent	A liquid used to reconstitute freeze-dried/lyophilized vaccine.
Disposable syringe	An all-plastic syringe designed for single use, with a separate steel needle. Because there is no mechanism for preventing reuse this type of syringe may, incorrectly, be used more than once.
Grossing factor	<p>Used for estimating space requirements for the cold storage and transportation of vaccines. Always 1.0 or greater.</p> <p>In the case of a cold store, refrigerator or freezer: the gross <i>internal</i> volume of the appliance divided by the net volume of vaccine that the appliance is capable of storing safely. Generally, vaccine is stored in its inner card packaging. However, in larger cold stores it may be stored in the manufacturer's shipping containers.</p> <p>In the case of a cold box or other transport container: the gross <i>external</i> volume of the container divided by the net volume of vaccine that the appliance is capable of storing safely.</p>
Monovalent vaccine	A vaccine containing antigen to induce protection against a single microorganism.
Utilization factor	A factor, always less than 1.0, which takes account of the difference between the manufacturer's theoretical capacity for a vehicle, cold box, syringe safety box or other transport container and its actual capacity in practical use.



---

**Vaccine vial monitor** A label sensitive to time-temperature which can be attached to a vaccine vial. Through a gradual and irreversible colour change it warns health workers whether vaccines have been degraded by unacceptable exposure to heat and whether they should therefore be discarded. The colour change follows the stability curve of the vaccine in question. Once the colour change is complete the vial should no longer be used.

---

# Preface

These guidelines have been developed by Ulla Kou of the Department of Vaccines and Biologicals. Extensive comments on the document were received from other members of the Department and a draft version was posted on the “Technet e-Forum” (Technical Network for Strengthening Immunization Services) for external review. Special thanks are offered to Anthony Battersby, FBA Health System Analysts, Rebecca Fields, the CHANGE project, Andrew Garnett, independent consultant, John Lloyd, PATH, Damian Walker, London School of Hygiene and Tropical Medicine and Xingzhu Liu, Abt Associates Inc., for their useful comments.



---

# 1. Introduction

Various new vaccines have entered the market during the last few years and more are expected to be developed in the future.<sup>1</sup> Governments have to decide whether to include new vaccines in the routine immunization schedule, which is publicly funded in most countries. They may decide not to do so and to leave uptake to the private sector. The rationale for introducing a new vaccine into government-funded national immunization services should firstly be based on whether the disease in question is a public health problem and, if it is, whether immunization is the best way to control it. Secondly, the overall costs of introducing the vaccine and maintaining sufficient coverage should be assessed.

In these guidelines a stepped approach is outlined for estimating the incremental costs of introducing new vaccines into routine immunization services. The overall objective is to assist public health officials who are considering whether to introduce new vaccines to plan and budget for such introductions. The perspective is thus that of the health sector: the costs that fall on parents and others are not taken into account.

The guidelines are targeted at immunization service managers, logisticians, policy-makers, researchers, international donors and health planners in developing countries. No prior experience or training in economics is necessary for using the guidelines.

---

<sup>1</sup> See Annex 1 for a summary of new and underused vaccines and vaccines under development.

---

## 2. Concepts of cost analysis

When carrying out the analysis it is necessary to be aware of some basic costing concepts. The most important ones relating to these guidelines are explained below. Further guidance on cost analysis is available in Creese and Parker (1994) and UNAIDS (2000).

### 2.1 Incremental versus full costs

Whereas a full cost analysis estimates the costs of all resources being employed in an immunization system, an incremental analysis only looks at the cost of an addition, e.g. a new vaccine, to existing services. It should be borne in mind that an incremental cost analysis underestimates the costs of a general administrative nature borne by the system and that it does not include overheads. For instance, in an incremental analysis of the addition of a new vaccine the building costs for delivering vaccinations are not included as these are assumed to be covered by the immunization system already in place.

### 2.2 Financial versus economic costs

Economists define costs as the value of resources used to produce a good or service. However, the way these resources are measured can differ. Financial costs represent actual expenditure on goods and services purchased. Costs are thus described in terms of how much money has been paid for the resources used. Economic costs, also referred to as opportunity costs, are, on the other hand, defined as resources that have been foregone for alternative uses. The basic idea behind this is that things have a value that may not be fully captured in the price. For example, when a new vaccine is introduced in a monovalent form, additional injections are required and the time spent on delivering the vaccine could be used to provide other productive services. This is therefore referred to as an opportunity cost. The health sector is unlikely to employ extra personnel to deliver the new vaccine, however, and consequently no financial costs are involved. If the new vaccine is donated by an external funding source there are no financial costs as nothing is paid by the government, but the marketed value of the vaccine should be used when estimating the economic costs .

Whether to use financial or economic costs depends on the purpose of the analysis. If the aim is to prepare a budget for immunization services, only the financial costs should be included. If, however, a cost-effectiveness analysis or a sustainability assessment of a new vaccine is required, the economic costs should be used. These guidelines explain how to estimate both financial and economic costs for each cost item included.

---

### **2.3 Capital versus recurrent costs**

When carrying out the costing exercise, all cost components should be divided into capital and recurrent costs. Capital costs are defined as items that last longer than one year and are therefore incurred only every few years rather than annually. For immunization services, important capital costs are associated with cold chain equipment and vehicles. Recurrent costs are those items that are used up during a year and are usually purchased regularly. Important recurrent costs are those associated with vaccines, injection supplies and training activities.

When estimating costs it is recommended that all figures be presented on an annual basis. This means that the value of capital items has to be spread over their expected life so that they can be combined with recurrent costs in a useful manner. There are two ways of annualizing capital costs, depending on whether financial costs or economic costs are under consideration. For financial costs the use of straight-line depreciation is recommended, whereby the replacement costs of an item are divided by its estimated number of years of life. For economic costs the value of alternative opportunities for resources tied up in capital inputs is of interest, and the capital costs therefore have to be annualized by introducing a discount rate. Both methods for depreciating capital items are explained in Annex 2.

---

## 3. How to identify and estimate costs

The best method for estimating the costs of introducing a new vaccine consists of identifying all the inputs required for the introduction along with their respective quantities and unit costs. The required types of input depend to some extent on whether the vaccine is to be introduced as a combination vaccine with one or more of the vaccines already present in the system or whether it is to be monovalent. A combination vaccine does not involve any additional injections and is therefore simpler to introduce than a monovalent vaccine. Furthermore, if the combination vaccine is procured in the same vial size as before the vaccine does not take up more space in the distribution system. If, on the other hand, the vaccine is monovalent, or if the combined vaccine is introduced with fewer doses per vial than previously used, or if an extra vial for diluent is required for the purpose of storage, the vaccine then takes up more space in the distribution system and this may necessitate expansion of the cold chain.

The input categories that have to be assessed, according to whether a monovalent or combination vaccine is being introduced, are summarized in Table 1. For a combination vaccine in the same vial size the only inputs to assess besides the vaccine itself are disease surveillance, training, stationery and social mobilization. For a monovalent vaccine, inputs such as syringes, waste management and expansion of the distribution system should also be assessed.

In the following sections, methods are described for estimating the costs of the different inputs outlined in Table 1. Explanations are given as to how to categorize the items according to capital, recurrent, financial and economic costs. Data collection forms are reproduced in Annex 8. Electronic versions of the forms can be downloaded from <http://www.who.int/vaccines/en/techdocs/forms.xls>. A method for presenting overall results is illustrated in Chapter 10.

---

**Table 1: Inputs to assess according to vaccine presentation**

Type of new vaccine	Inputs to assess
Combination vaccine with no change in vial size and no extra vials for diluent	<ol style="list-style-type: none"><li>1. Supplies: vaccines</li><li>2. Disease surveillance</li><li>3. Other costs: training, stationery, social mobilization</li></ol>
Combination vaccine with fewer doses per vial than previously used and/or with extra vials for diluent	<ol style="list-style-type: none"><li>1. Supplies: vaccines and reconstitution syringes</li><li>2. Distribution system: transport and cold storage</li><li>3. Disease surveillance</li><li>4. Other costs: training, stationery, social mobilization</li></ol>
Monovalent vaccine	<ol style="list-style-type: none"><li>1. Supplies: vaccines, syringes, safety boxes</li><li>2. Distribution system: transport and cold storage</li><li>3. Waste management</li><li>4. Personnel</li><li>5. Disease surveillance</li><li>6. Other costs: training, stationery, social mobilization</li></ol>



---

## 4. Vaccine supplies

Vaccine supplies consist of vaccines, syringes and safety boxes. They represent a recurrent cost since they must be procured regularly. If supplies are procured without donor support they should be classified as financial costs. If there is donor support they should be classified as economic costs. Form A5 (Annex 8) should be used for summarizing the costs of vaccine supplies.

### 4.1 Vaccines

The total vaccine costs per year,  $c$ , are estimated as

$$c = p \times n,$$

where

$p$  = price per dose of new vaccine, including freight expenditures;

$n$  = number of doses supplied.

The number of doses supplied for the first year,  $n$ , is estimated as

$$n = i \times b \times d \times (1/(1 - w)) \times (1 + r),$$

where

$i$  = immunization coverage rate;

$b$  = birth cohort;

$d$  = number of doses per fully immunized child (FIC);

$w$  = wastage rate (%);

$r$  = reserve stock (%).

In order to estimate the number of doses needed for subsequent years the same formula should be used except that the reserve stock should be excluded and any vaccine in stock should be subtracted from the number of estimated doses, as follows.

$$n = i \times b \times d \times (1/(1-w)) - s,$$

where

$s$  = number of vaccine doses in stock.

If a combination vaccine is to be introduced the annual costs of the vaccine to be replaced by it should be subtracted from the total costs so as to obtain an estimate of the additional costs. For instance, if HepB-DTP combination vaccine is being introduced the annual costs of DTP vaccine should be subtracted.

An example of the calculation is given in Box 1 and suggestions on how to estimate the different variables included in the formula are outlined below.

---

### ***Vaccine price:***

Current vaccine prices can be obtained from the manufacturers or UNICEF and/or PAHO. UNICEF's supply division and PAHO's Revolving Fund operate as vaccine procurement mechanisms for a number of developing countries.<sup>2</sup>

### ***Coverage rate:***

A target coverage rate for the year in question should be used. The rate should be based on the current coverage rate and predicted changes in services. For instance, if the first dose of the new vaccine is given at birth, the coverage rate of BCG can be used for estimating the target coverage rate. If the new vaccine is going to follow the DTP schedule, an average of the coverage rates of DTP-1, DTP-2 and DTP-3 can be used.

### ***Birth cohort:***

Information on the estimated annual number of neonates for the year in question can be collected from the national statistical bureau or a related office.<sup>3</sup>

### ***Number of doses per FIC:***

The number of doses per FIC is obtained from the agreed immunization schedule.

### ***Wastage rates:***

Wastage rates depend on the number of doses in a vial, whether or not the country in question has an open vial policy, the sizes of immunization sessions, any cold chain and distribution failures, and the number of vials discarded due to expiry.

If a new vaccine is combined with one of the existing vaccines and if there is no change in vial size, wastage rates for the existing vaccine can be used. Otherwise the wastage rate of the new vaccine should be estimated by making a comparison with other vaccines. Whether the wastage rate is the same as that for another vaccine depends on whether the vaccines are of similar type, whether the same schedule is used for both and whether the same number of doses is used per vial. Wastage rates may differ in various settings, depending on factors such as population density and delivery strategy (e.g. fixed site versus outreach). The national wastage estimate for a particular vaccine should be a weighted average of the wastage rates for different settings.

---

<sup>2</sup> Information about UNICEF's supply division can be found on the Internet at: [www.supply.unicef.dk](http://www.supply.unicef.dk).

<sup>3</sup> WHO policy for estimating immunization coverage is to use the birth cohort for BCG and TT, and to use the number of surviving infants for DTP, measles and polio vaccines. However, for the purpose of forecasting vaccine supply the total number of births is recommended as the denominator, since this generates the highest number and thus ensures that sufficient vaccine is procured.

---

Wastage rates are calculated by comparing the number of doses administered with the number of vials opened for use and with the number of closed vials that are discarded because of cold chain failure, VVM indication or expiry. Wastage rates can be estimated using data from either national or subnational records of doses administered and/or from stock records.

When using data from national or subnational records of doses administered the following formula should be used to estimate the wastage factor,  $f$ .

$$f = ((v + c) \times d)/n,$$

where

$v$  = number of vials opened for use;

$c$  = number of closed vials discarded because of cold chain failure or VVM indication;

$d$  = number of doses per vial;

$n$  = number of doses administered.

The wastage factor is converted to a percentage wastage rate  $w$  as follows.

$$w = 100 - (100/f).$$

When using stock records the following formula should be used to estimate the wastage factor.

$$f = ((b + c - d) \times e)/n,$$

where

$b$  = number of usable vials in stock at start of year;

$c$  = number of vials issued from store for use during year;

$d$  = number of usable vials in stock at end of year ;

$e$  = number of doses per vial;

$n$  = number of doses administered.

Again, the wastage factor is converted to a percentage wastage rate,  $w$ , as follows.

$$w = 100 - (100/f).$$

### ***Reserve stock:***

For the first order of vaccines a reserve stock must be included in the estimate of the number of doses. This is usually set at 25%. The extra vaccine supply should be distributed throughout the country. For subsequent orders a reserve stock is not included as it is already in place, revolving as a buffer stock.

---

**Box 1: Example of estimation of total annual vaccine costs  
for a new vaccine**

The following assumptions are made.

- p = US\$ 2 (price per dose)
- i = 0.7 (70%)
- b = 2.5 million children
- d = 3 doses per fully immunized child
- w = 0.3 (30%)
- r = 0.25 (25%)
- s = 200 000 doses in stock after one year

The number of doses, n, supplied for the first year is estimated as follows.

$$\begin{aligned}n &= i \times b \times d \times (1/(1-w)) \times (1+r) \\ &= 0.7 \times 2\,500\,000 \times 3 \times (1/(1-0.3)) \times (1+0.25) \\ &= 9\,375\,000 \text{ doses}\end{aligned}$$

Since the price per dose is assumed to be \$2, the total vaccine cost, c, for the first year is estimated as follows.

$$\begin{aligned}c &= 2 \times 9\,375\,000 \\ &= \text{US\$ } 18\,750\,000\end{aligned}$$

For subsequent years, annual vaccine costs are estimated as:

$$\begin{aligned}n &= 0.7 \times 2,500\,000 \times 3 \times (1/(1-0.3)) - 200\,000 = 7,300\,000 \\ c &= 2 \times 7,300\,000 = \text{US\$ } 14,600\,000\end{aligned}$$

## 4.2 Injection syringes

If a new vaccine is introduced as a monovalent vaccine, additional syringes per FIC are needed. The total annual costs for syringes, c, are estimated as follows.

$$c = p \times s,$$

where

p = price per syringe, including freight expenses;

s = annual number of syringes needed.

---

For the first year the annual number of syringes is estimated as follows.

$$s = n \times (1/(1 - w)) \times (1 + r),$$

where

n = number of injections administered per year;

w = wastage rate (%);

r = reserve stock (%).

The annual number of injections administered, n, is estimated as follows.

$$n = c \times b \times d,$$

where

c = coverage rate;

b = birth cohort;

d = number of doses of the new vaccine per FIC.

The definitions and the sources of these variables are explained in Section 4.1.

The wastage rate of syringes is normally considerably lower than that for vaccines. It is generally recommended to plan for about 10% wastage of syringes. A reserve stock should be included for the first year of procurement. It is normally set at 25% but can vary with delivery schedules.

The prices of syringes can be obtained from supply invoices, order forms, price lists and catalogues. The costs of international transport should be included (UNICEF's supply division can provide average estimates of freight costs as a percentage of the load).

### 4.3 Reconstitution syringes

Each vial of freeze-dried vaccine must be reconstituted with a sterile reconstitution syringe. The total annual costs of reconstitution syringes, c, are estimated as follows.

$$c = p \times s,$$

where

p = price per syringe, including freight expenses;

s = annual number of reconstitution syringes needed.

For the first year the number of reconstitution syringes is estimated as follows.

$$s = n/v \times (1/(1 - w)) \times (1 + r),$$

where

n = number of doses of freeze-dried vaccine administered per year;

v = number of doses per vial;

w = wastage rate (%);

r = reserve stock (%).

The annual number of doses of vaccine administered, n, is estimated as in Section 4.1.

---

As with injection syringes, it is generally recommended to plan for about 10% wastage. A reserve stock should be included for the first year of procurement. It is normally set at 25%.

The prices of reconstitution syringes can be obtained from supply invoices, order forms, price lists and catalogues. The costs of international transport should be included.

#### 4.4 Safety boxes

Contaminated needles and syringes must always be stored in puncture-resistant containers, referred to as safety boxes. Additional safety boxes are needed if the introduction of a new vaccine involves additional injections per FIC. The cost of additional safety boxes is estimated as follows.

$$c = p \times n,$$

where

p = unit price of safety box, including freight expenses;

n = number of safety boxes needed annually.

The number of safety boxes needed annually is estimated as follows.

$$n = s/a \times (1/(1 - w)),$$

where

s = annual number of additional syringes arising from introduction of the new vaccine as estimated above (for the first year a reserve stock should be included);

a = capacity of safety box (number of syringes stored);

w = wastage rate (%).

For example, if a safety box has a capacity of 140 AD syringes and if it is estimated that 800 000 syringes will be used per year as a consequence of the introduction of a new vaccine, a minimum of  $800\,000/140 = 5714$  safety boxes are needed. Furthermore, it is recommended that a wastage rate of 50%-100% be added to allow for the disposal in safety boxes of sharps other than immunization syringes.

Information on the capacities of different types of safety boxes and their prices can be found in the WHO/UNICEF *Product Information Sheets* (WHO/V&B/00.13).

---

## 5. Waste management

If a new vaccine is introduced as monovalent, additional injections are required and the capacity of the waste management system must therefore be assessed. Moreover, in certain places the introduction of a new vaccine might encourage a switch from sterilizable syringes to AD syringes. In this event it is necessary to plan for a relatively large investment in waste management.

In developed and middle-income countries, relatively sophisticated waste management systems, such as those involving high-temperature incineration and autoclaving, are often used in order to secure the safe and environmentally friendly destruction of syringes and other health care waste. For less developed countries these options are rarely feasible because of economic constraints. Instead, low-cost options such as the instalment of small-scale incinerators at selected health centres and district hospitals should be considered.

The resources required for effective waste management may include the capital cost of incinerators and any buildings required to house them. Recurrent costs include those associated with incinerator fuel and maintenance, training, and salaries of staff. If the incinerator is not located where immunization is performed the cost of transporting the safety boxes also has to be taken into account. Forms A1 and A6 should be used for summarizing capital and recurrent supply costs related to waste management; form A10 should be used for personnel costs (Annex 8).

---

# 6. Distribution system

It may be necessary to expand the capacity of the distribution system in order to make space for additional vaccines and syringes. The costs can be separated into those of transport and vaccine storage (often referred to jointly as the cold chain). If there is considerable spare capacity in existing refrigerated storage at one or more levels of the system it should not be necessary to expand the storage space. If, however, there is limited spare capacity it may be possible to shorten the supply interval at one or more levels so that the volume required for storage is reduced and the transport requirement is increased.<sup>4</sup>

## 6.1 Transportation of vaccines

At each transport link in the cold chain a calculation must be made of the total volume of vaccines to be transported. If it exceeds the capacity of the available transport the transportation system must be intensified. This may require investment in additional vehicles or a shorter supply interval.

Annex 3 outlines a method for calculating vaccine volumes. The calculation gives an estimate in cubic metres of the additional storage volume needed when a new vaccine is introduced. A percentage increase is also calculated. This allows a rough assessment of whether the current capacity of the system can accommodate the additional volume. The assessment should be made at the national, subnational and service levels of transportation. At the service level the transportation of vaccines is often based on a collection programme whereby health facilities use their own transport to collect supplies from a store at a higher level. Where this happens it may be difficult to make an accurate estimate of spare capacity. If this is the case an average capacity in various districts has to be worked out on the basis of interviews with district supply managers.

The worksheet in Annex 3 gives an estimate of the packed volume of vaccines according to the capacity stated by manufacturers of cold boxes. However, as all cold boxes are unlikely to be completely filled with vaccines and as all vehicles are unlikely to be fully loaded, a safety margin in the form of a utilization factor should also be adopted when assessing whether to expand a transportation system.

---

<sup>4</sup> The supply interval is normally defined as the number of weeks between deliveries of fresh supplies of vaccine.



---

When the capital costs for transport (e.g. cars, motorcycles, bicycles) are being estimated, useful information on prices can be obtained from recent government contracts, supply records from donors, or local dealer estimates. The working life of a vehicle is needed for calculating its annualized value (Annex 2). Annualized values vary considerably, depending on the type of vehicle, the terrain, and use and maintenance practices. Estimates can be made on the basis of information obtained by asking people who use, drive or service cars, motorcycles and bicycles. Data on these matters should be entered on form A2.

Additional recurrent costs associated with the expansion of a transportation system include those for fuel, lubricants, insurance, registration fees, maintenance costs, and salaries and per diems for drivers. Expenditure records may give some indication of the costs of operating and maintaining vehicles, but interviews with drivers and mechanics and the consultation of logbooks is likely to be needed in order to obtain a sufficiently detailed picture (Creese and Parker, 1994). Forms A2 and A8 (Annex 8) should be used to record these data.

## **6.2 Cold storage**

An assessment should be made as to whether current cold storage capacity can accommodate the introduction of a new vaccine. As with transport, the evaluation should be made by comparing the available volume with the required volume. A method for calculating the additional cubic metres of storage volume required on introducing a new vaccine is outlined in Annex 4.

When the required percentage increase in storage volume has been calculated the current capacity of the system should be assessed. In many countries the current capacity varies considerably with the administrative level. Spare capacity in refrigerators is relatively large in health centres in many places but is often smaller at the district, provincial and central levels.

Expansion of the cold chain could lead to an increase in capital costs in the form of additional cold stores, refrigerators, freezers, stand-by generators and cold boxes. Additional recurrent costs are likely to include electricity, gas, ice packs, kerosene, spare parts and workshop costs. Cost data on different types of cold chain equipment can be found in the WHO/UNICEF *Product Information Sheets*, which are regularly updated. The costs of items used for maintenance of the cold chain should be obtained from expenditure records. The information should be entered on forms A3 and A9 (Annex 8).

## **6.3 Storage and transportation of injection equipment and waste management supplies**

If a monovalent vaccine is introduced, additional syringes and safety boxes must be procured and it is necessary to assess whether sufficient transport and storage space is available for them. This assessment should be made by comparing the available transport and storage space with the space needed at all levels of the vaccine supply chain.

---

Details of the packed volumes of syringes and flat-packed safety boxes can be found in the WHO/UNICEF *Product Information Sheets*. At the most, 1 cubic metre of net storage volume should be allowed for every 15 000 syringes, i.e. 0.067 cubic metres per 1000 syringes. However, in the 2000 edition of the *Product Information Sheets* the number of syringes that can be held in 1 cubic metre is given as ranging from 16 000 to 29 000. If the type of syringes to be procured is known the exact storage volume should be used, as indicated in the *Product Information Sheets* or by the manufacturers.

For safety boxes there is considerable variation in the packed volume before they are assembled and in the number of syringes they can accommodate. In the 2000 edition of the *Product Information Sheets* the volume of packed boxes per 1000 syringes varies from 0.004 to 0.014 cubic metres. If the type of safety box to be procured is unknown, the latter figure should be used when assessing whether there is sufficient storage space, i.e. 0.014 cubic metres should be available per 1000 syringes.

If it is assessed that additional storage and transport space is needed because of the introduction of a new vaccine, the required investment should be estimated as a capital cost (Annex 2). Detailed guidance on establishing or improving vaccine and supplies stores is given in *Guidelines for establishing or improving national, regional and district vaccine stores* (WHO/EPI/LHIS/96.03). Costing principles for buildings are indicated in Creese and Parker (1994) and UNAIDS (2000).

---

## 7. Personnel

A wide range of staff members are involved in managing a new vaccine, including managers, surveillance staff, community health workers, nurses and doctors. If extra personnel are employed to deliver the new vaccine, they should be classified as a financial cost. If no additional staff are required, salaries should be classified as economic costs and should only be included in the analysis if the purpose is to determine cost-effectiveness.

No staff are likely to work exclusively on a new vaccine. Personnel costs should therefore be assessed on the basis of time allocations. In certain instances, however, the question may arise as to whether salary costs should be included at all. If immunization staff are known to have a considerable amount of non-productive time during working hours it should not be necessary to include additional salary costs in the estimation, since the opportunity cost for these staff is almost zero (i.e. no other productive tasks will be sacrificed as a result of the introduction of a new vaccine). If, on the other hand, immunization staff are known to be busy and highly productive, additional salary costs should be considered in an economic costs analysis, since less time would be available for other services because of the introduction of the new vaccine.

Personnel costs should be calculated by using form A10 (Annex 8). Data on the annual costs for each type of staff working with the new vaccine should be obtained and costs should then be allocated according to the time spent on it. For immunization delivery staff this can be done by estimating the number of minutes required for delivery of the new vaccine to each child.

Information on salary levels can usually be obtained from health ministry payrolls. The full salary cost should be used, i.e. take-home pay plus any additional benefits such as contributions to health insurance, social security, pension plans and taxation. These gross earnings should include any incentive payments, overtime, hardship allowances, holiday and sick pay, and allowances for uniforms, housing and travel (Creese and Parker, 1994). Salaries are categorized as recurrent costs.

---

# 8. Surveillance and monitoring

When a new vaccine is introduced it is essential to monitor programme output and disease control impact. This activity should be integrated as much as possible into ongoing disease surveillance and monitoring activities. When estimating the incremental costs of increased surveillance activity attributable to the introduction of a new vaccine it is important to take account of additional staff costs, training, data management, communications, transport, specimen collection and dispatch, and laboratory services.

Annex 6 provides an example of usual budget items for disease surveillance. The type of items needed depends to a certain extent on the type of surveillance being implemented, i.e. whether passive, active or both. Form A7 should be used to record supplies and form A10 to record personnel (Annex 8).

## 8.1 Stationery

It is important to redesign stationery such as immunization summary reports, tally sheets and vaccination cards so that it includes the new vaccine. The cost of changing the design of stationery can be obtained from the supplier of these items. If it is a one-off cost it is classified as capital expenditure. If the unit cost of the stationery rises in subsequent years the increases should be included as recurrent costs.

---

## 9. Other costs

Other costs related to the introduction of a new vaccine are those of social mobilization, training of health staff, and changes in immunization forms and other stationery. Forms A4 and A5 (Annex 8) should be used in data collection for these activities, depending on whether the inputs are classified as capital or recurrent costs.

### 9.1 Social mobilization

Advocacy and social mobilization efforts are crucial for ensuring the successful introduction of a new vaccine. The aim of these activities is to inform the general public and health care workers about the decision to introduce the vaccine and the consequences. Furthermore, the introduction of a new vaccine presents a good opportunity to promote immunization services in general. The extent of social mobilization is likely to vary from place to place, depending on perceived needs and available funds. In some countries, large-scale advocacy campaigns involving the participation of senior politicians and extensive media coverage have been carried out when a new vaccine has been introduced. The types of advocacy that can be considered include the development and distribution of posters and booklets and the broadcasting of radio and TV spots that inform the public about the new vaccine.

The costs of carrying out social mobilization and advocacy activities can be estimated either by comparison with the costs of similar activities conducted for immunization or other public health initiatives or by preparing a detailed plan of activities with budget estimates. As social mobilization is a one-off activity conducted only at the time of introduction it should be classified as a capital cost.

### 9.2 Training

Health care workers should receive training in the administration of a new vaccine. This is likely to require training workshops as well as the development of training materials in the form of leaflets or brochures about the new vaccine. It may also be considered necessary to update routine immunization training material to include the new vaccine. If training on the new vaccine is limited to the period just before or during its introduction, the costs should be classified as capital expenditure. If, however, training on the new vaccine is planned to continue in successive years the costs should be classified as recurrent. The costs of developing and printing training materials can either be obtained from private sector quotations or by making estimates on the basis of comparison with the costs of other training materials recently developed in the health sector.

---

# 10. Presenting and analysing results

Cost estimates should be presented so that the reader can easily identify the origin of the figures. Costs should be presented not only as totals but also as quantities and unit costs. This is ensured by the use of forms A1 to A10 (Annex 8). The estimates in these forms should be compiled and summarized as in Table 2. An electronic form can be downloaded from the Internet at <http://www.who.int/vaccines/en/techdocs/forms.xls>. In a second stage, costs can be presented according to currency, by source of support (i.e. health ministry, donors and other government departments), or by level (i.e. national, regional, district administration and health centre). This enables partners rapidly to obtain an understanding of their different roles in the process (Creese and Parker, 1994).

**Table 2: Summary of costs of introducing a new monovalent vaccine**

Cost category	Annual financial costs	% of total costs	Annual economic costs	% of total costs
<i>Capital costs</i>				
Vehicles				
Cold chain equipment				
Incinerators				
Training material				
Social mobilization				
Redesign of stationery				
<i>Total capital costs</i>				
<i>Recurrent costs</i>				
Vaccines				
Syringes				
Safety boxes				
Waste management				
Surveillance				
Cold chain storage operation and maintenance				
Transport operation and maintenance				
<i>Total recurrent costs</i>				
<i>Total costs</i>				

---

# Bibliography

Creese A, Parker D, editors. *Cost analysis in primary health care. A training manual for programme managers*. Geneva: World Health Organization; 1994.

Drummond MF, O'Brian B, Stoddart, GL, Torrance GW. *Methods for the economic evaluation of health care programmes*. Oxford: Oxford Medical Publications; 1997.

Edmunds WJ, Dejene A, Mekonnen Y, Haile M, Alemnu W and Nokes DJ. The cost of integrating hepatitis B virus vaccine into national immunization programmes: a case study from Addis Ababa. *Health Policy and Planning* 2000; 15(4):418-416.

Hodge M, Haghgou M, Birmingham M. *Making surveillance work. Module 3: Logistics management*. Geneva World Health Organization; 2000 (unpublished document WHO/V&B/01.10; available from Vaccines and Biologicals, World Health Organization, 1211 Geneva 27, Switzerland and on the Internet at <http://www.who.int/vaccines-documents/DocsPDF01/www539.pdf>).

UNAIDS. *Costing guidelines for HIV prevention strategies*. Geneva: UNAIDS; 2000.

*Cold chain. Logistics for health worksheets*. Geneva: World Health Organization; 1995 (unpublished document EPI/WHO/LHIS/95.01-05; available from Vaccines and Biologicals, World Health Organization, 1211 Geneva 27, Switzerland).

*Monitoring vehicle use. A guide for transport officers*. Geneva: World Health Organization; 1997 (unpublished document WHO/EPI/LHIS/94.06; available from Vaccines and Biologicals, World Health Organization, 1211 Geneva 27, Switzerland).

*Guidelines for establishing or improving national, regional and district vaccine stores*. Geneva: World Health Organization; 1998 (unpublished document WHO/EPI/LHIS/96.03; available from Vaccines and Biologicals, World Health Organization, 1211 Geneva 27, Switzerland).

*Product Information Sheets*. Geneva, WHO and UNICEF; 2000 (unpublished document WHO/V&B/00.13; available from Vaccines and Biologicals, World Health Organization, 1211 Geneva 27, Switzerland and on the Internet at <http://www.who.int/vaccines-documents/DocsPDF00/www518.pdf>).

*Assessing new vaccines for national immunization programmes. A framework to assist decision-makers*. Manila: World Health Organization, Regional Office for the Western Pacific; 2000.



---

# **Annex 1:**

## **New and underused vaccines and vaccines under development (as of late 2001)**

Pathogen (syndrome)	Disease	Status formulations	Available combinations	Available
Yellow fever	Yellow fever	Available since 1935 (modified in 1945)	Lyophilized and reconstituted with diluent at time of use	None
Rubella	Rubella (German measles)	Available since 1969	Lyophilized and reconstituted with diluent at time of use	MMR, MR
Hepatitis B	Cirrhosis of the liver Primary liver cancer	Available since 1981	Liquid	DTP-HepB DTP-Hib-HepB Hib-HepB
<i>Haemophilus influenzae</i> type b	Pneumonia, meningitis and otitis media	Available since the late 1980s	Liquid or lyophilized and reconstituted with diluent or DTP	DTP-Hib DTP-Hib-HepB DTP-Hib-IPV Hib-HepB
Japanese encephalitis virus	Japanese encephalitis	Available since the 1970s	Liquid or lyophilized and reconstituted with diluent at time of use	None
Varicella	Varicella/chicken pox	Available since 1994	Liquid	None
<i>Streptococcus pneumoniae</i> conjugate vaccine	Meningitis, pneumonia and otitis media	7-valent vaccine licensed in USA in 1999	Liquid	None
<i>Vibrio cholerae</i>	Cholera	Live and killed vaccines available since early 1990s. New candidates under development.	Liquid	None
Typhoid	Diarrhoeal disease	Live and subunit vaccines available since early 1990s. New candidates under development.	Liquid	None
Meningococcal conjugate serogroup C	Meningococcal meningitis	Licensed in United Kingdom in 1999	Liquid	None
Meningococcal conjugate serogroup B	Meningococcal meningitis	OMV vaccine licensed in Latin America. Only suitable for outbreak control.	Liquid	None
Influenza nasal	Influenza	Licensed in Switzerland in 2000	Intranasal spray	None
Meningococcal conjugate serogroups A, C, Y, W135	Meningococcal meningitis	Under development	–	–
Rotavirus	Diarrhoeal disease	Under development	–	–
<i>Shigella</i>	Diarrhoeal disease	Under development	–	–
Enterotoxigenic <i>Escherichia coli</i>	Diarrhoeal disease	Under development	–	–
Dengue	Dengue and dengue haemorrhagic fever	Under development	–	–
<i>Plasmodium falciparum</i>	Malaria	Under development	–	–
Human immunodeficiency virus	Acquired immunodeficiency syndrome	Under development	–	–
Respiratory syncytial virus	Acute respiratory illness	Under development	–	–

---

# Annex 2:

## Annualization of capital costs

Capital items are purchased one year and used during several further years. To be combined with recurrent costs in a useful way their costs must be expressed on an annual equivalent basis. Two methods for annualizing capital costs are explained below, one for financial analysis, the other for economic analysis.

### Financial capital costs

In order to estimate financial capital costs the total costs of an item are divided by the number of years of its expected life to give its straight line depreciation. The following approach should be used.

1. Identify the capital cost items that are expected to occur with the introduction of a new vaccine.
2. Determine the current value of each item (i.e. the purchase price from the supplier).
3. Estimate the number of years of useful life which the item can realistically be expected to have (from the time of purchase).
4. Divide the number of years of useful life by the current value. This gives an average annual cost.

### Economic capital costs

The financial approach to annualizing capital items does not take into account the value of alternative opportunities for using the resources tied up in capital inputs. In order to calculate the economic costs of capital on an annualized (cost per year) basis, the following approach should be used.

1. Identify the capital cost items that are expected to occur with the introduction of a new vaccine.
2. Determine the current value of each item (i.e. the purchase price from the supplier).
3. Estimate the number of years of useful life which the item can realistically be expected to have (from the time of purchase).
4. Obtain the discount rate used by the economic planning office or ministry of finance (alternatively, calculate the real rate of interest, i.e. the rate of interest that could be obtained by depositing money in a bank, minus the inflation rate).

- 
5. Consult Table 3, which gives annualization factors for capital items with different expected lifetimes at different discount rates. The values in Table 3 are calculated from the following formula.

$$\frac{(1+r)^t - 1}{r(1+r)^t},$$

where  $r$  is the discount rate and  $t$  is the number of years after year 0.

6. Calculate the annual cost by dividing the current value of the item by the annualization factor.

***Example:***

A vehicle costs US\$ 10 000 and is expected to serve for five years before being scrapped. With a discount rate of 10% the table shows that the annualization factor is 3.791. The annual cost is thus:  $\$10\,000/3.791 = \$2638$  (rounded figure).

**Table 3: Annualization Factors**

Discount Rate	Expected useful life in years																			
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	0.901	0.893	0.885	0.877	0.870	0.862	0.855	0.847	0.840	0.833
2	1.970	1.942	1.913	1.886	1.859	1.833	1.808	1.783	1.759	1.736	1.713	1.690	1.668	1.647	1.626	1.605	1.585	1.566	1.547	1.528
3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.444	2.402	2.361	2.322	2.283	2.246	2.210	2.174	2.140	2.106
4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.102	3.037	2.974	2.914	2.855	2.798	2.743	2.690	2.639	2.589
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.696	3.605	3.517	3.433	3.352	3.274	3.199	3.127	3.058	2.991
6	5.795	5.601	5.417	5.242	5.076	4.917	4.767	4.623	4.486	4.355	4.231	4.111	3.998	3.889	3.784	3.685	3.589	3.498	3.410	3.326
7	6.728	6.472	6.230	6.002	5.786	5.582	5.389	5.206	5.033	4.868	4.712	4.564	4.423	4.288	4.160	4.039	3.922	3.812	3.706	3.605
8	7.652	7.325	7.020	6.733	6.463	6.210	5.971	5.747	5.535	5.335	5.146	4.968	4.799	4.639	4.487	4.344	4.207	4.078	3.954	3.837
9	8.566	8.162	7.786	7.435	7.108	6.802	6.515	6.247	5.995	5.759	5.537	5.328	5.132	4.946	4.772	4.607	4.451	4.303	4.163	4.031
10	9.471	8.983	8.530	8.111	7.722	7.360	7.024	6.710	6.418	6.145	5.889	5.650	5.426	5.216	5.019	4.833	4.659	4.494	4.339	4.192
11	10.368	9.787	9.253	8.760	8.306	7.887	7.499	7.139	6.805	6.495	6.207	5.938	5.687	5.453	5.234	5.029	4.836	4.656	4.486	4.327
12	11.255	10.575	9.954	9.385	8.863	8.384	7.943	7.536	7.161	6.814	6.492	6.194	5.918	5.660	5.421	5.197	4.988	4.793	4.611	4.439
13	12.134	11.348	10.635	9.986	9.394	8.853	8.358	7.904	7.487	7.103	6.750	6.424	6.122	5.842	5.583	5.342	5.118	4.910	4.715	4.533
14	13.004	12.106	11.296	10.563	9.899	9.295	8.745	8.244	7.786	7.367	6.982	6.628	6.302	6.002	5.724	5.468	5.229	5.008	4.802	4.611
15	13.865	12.849	11.938	11.118	10.380	9.712	9.108	8.559	8.061	7.606	7.191	6.811	6.462	6.142	5.847	5.575	5.324	5.092	4.876	4.675
16	14.718	13.578	12.561	11.652	10.838	10.106	9.447	8.851	8.313	7.824	7.379	6.974	6.604	6.265	5.954	5.668	5.405	5.162	4.938	4.730
17	15.562	14.292	13.166	12.166	11.274	10.477	9.763	9.122	8.544	8.022	7.549	7.120	6.729	6.373	6.047	5.749	5.475	5.222	4.990	4.775
18	16.398	14.992	13.754	12.659	11.690	10.828	10.059	9.372	8.756	8.201	7.702	7.250	6.840	6.467	6.128	5.818	5.534	5.273	5.033	4.812
19	17.226	15.678	14.324	13.134	12.085	11.158	10.336	9.604	8.950	8.365	7.839	7.366	6.938	6.550	6.198	5.877	5.584	5.316	5.070	4.843
20	18.046	16.351	14.877	13.590	12.462	11.470	10.594	9.818	9.129	8.514	7.963	7.469	7.025	6.623	6.259	5.929	5.628	5.353	5.101	4.870
21	18.857	17.011	15.415	14.029	12.821	11.764	10.836	10.017	9.292	8.649	8.075	7.562	7.102	6.687	6.312	5.973	5.665	5.384	5.127	4.891
22	19.660	17.658	15.937	14.451	13.163	12.042	11.061	10.201	9.442	8.772	8.176	7.645	7.170	6.743	6.359	6.011	5.696	5.410	5.149	4.909
23	20.456	18.292	16.444	14.957	13.489	12.303	11.272	10.371	9.580	8.883	8.266	7.718	7.230	6.792	6.399	6.044	5.723	5.432	5.167	4.925
24	21.243	18.914	16.936	15.247	13.799	12.550	11.469	10.529	9.707	8.985	8.348	7.784	7.283	6.835	6.434	6.073	5.746	5.451	5.182	4.937
25	22.023	19.523	17.413	15.622	14.094	12.783	11.654	10.675	9.823	9.077	8.422	7.843	7.330	6.873	6.464	6.097	5.766	5.467	5.195	4.948
26	22.795	20.121	17.877	15.983	14.375	13.003	11.826	10.810	9.929	9.161	8.488	7.896	7.372	6.906	6.491	6.118	5.783	5.480	5.206	4.956
27	23.560	20.707	18.327	16.330	14.643	13.211	11.987	10.935	10.027	9.237	8.548	7.943	7.409	6.935	6.514	6.136	5.798	5.492	5.215	4.964
28	24.316	21.281	18.764	16.663	14.898	13.406	12.137	11.051	10.116	9.307	8.602	7.984	7.441	6.961	6.534	6.152	5.810	5.502	5.223	4.970
29	25.066	21.844	19.188	16.984	15.141	13.591	12.278	11.158	10.198	9.370	8.650	8.022	7.470	6.983	6.551	6.166	5.820	5.510	5.229	4.975
30	25.808	22.396	19.600	17.292	15.372	13.765	12.409	11.258	10.274	9.427	8.694	8.055	7.496	7.003	6.566	6.177	5.829	5.517	5.235	4.979

---

# Annex 3:

## Calculating packed volume for transport

Worksheet 1 in this Annex should be used when estimating the increase in packed volume following the introduction of a new vaccine.<sup>5</sup> The principle of the worksheet is that the storage volume is estimated for vaccines in the existing as well as in the new immunization schedule and that the increase in packed volume caused by introducing the new vaccine is assessed. The increase is estimated both in cubic metres and as a percentage. An electronic version of the worksheet can be downloaded from the Internet at <http://www.who.int/vaccines/en/techdocs/worksheet.xls>. Alternatively, a more simple version of the calculation, the vaccine volume calculator, in which only the percentage increase in storage space caused by introducing a new vaccine is estimated, can be found at <http://www.who.int/vaccines-documents/Excel/www586.xls>. Here the grossing factor is not taken into account and there is therefore no distinction between transportation and cold storage.

The information that is necessary when filling in the worksheet is indicated below.

### **Column B:**

Information on packed volume per dose can be obtained from the vaccine supplier. Selected vaccine volumes are summarized in Annex 5.

### **Column G:**

For transport, the grossing factor accounts for the extra space needed for ice packs and the insulation of cold boxes or other transport containers. In order to account for this extra space, vaccine volumes are multiplied by a grossing factor of at least 1.0.

Transport grossing factors vary with the type of cold box used. In order to make an estimate it is therefore necessary to know what type of cold box is most frequently used when transporting the vaccines to regions and districts. The specifications of several cold boxes are summarized in the WHO/UNICEF *Product Information Sheets*. In order to estimate the grossing factor, the external dimensions of the box should be divided by the vaccine storage capacity. An example of this calculation is given in Table 4 for a cold box specified in the 2000 *Product Information Sheets*.

---

<sup>5</sup> The packed volume is the volume of the vaccine plus insulated packaging.

---

**Table 4: Calculation of transport grossing factor**

RCW 12/CF cold box		
		cm <sup>3</sup>
External dimensions (cm)	50 x 55 x 47	129 250
Vaccine storage capacity (litres)	8.5	
Vaccine storage capacity (cm <sup>3</sup> )	8.5 x 1000	8 500
Grossing factor (external dimensions/vaccine storage capacity)		15.2

**Column I:**

The annual number of births is used without taking the coverage rate into account. This is recommended because transport is a capital item that should last for years. It is therefore advised that a predicted or desirable coverage rate be used when estimating storage volume. In using the annual number of live births a coverage rate of 100% is assumed. If this is considered very unrealistic the number of live births can be multiplied by an objective coverage rate to give a smaller required total storage volume.

**Column K:**

The annual supply interval is the number of times per year that vaccines are transported to provinces, districts and health centres.

**Worksheet 1: Estimation of packed volume of vaccines for transport**

Vaccine	No. of doses per vial	Packed volume per dose (cm <sup>3</sup> )	No. of doses per FIC	Vaccine wastage rate (%)	Wastage factor	Net storage volume per FIC (cm <sup>3</sup> )	Transport grossing factor	Total storage volume per FIC (cm <sup>3</sup> )	Annual number of live births	Total annual vaccine storage volume (cm <sup>3</sup> )	Annual supply interval	Storage volume per transport load (cm <sup>3</sup> )	Storage volume per transport load (m <sup>3</sup> )
	A	B	C	D	$E = \frac{1}{1 - D}$	$F = B \times C \times E$	G	$H = F \times G$	I	$J = H \times I$	K	L = J/K	M = L/1000 000
Vaccines in existing schedule:													
<b>Total</b>													
Vaccines in new schedule:													
<b>Total</b>													
<b>Increase in storage volume caused by introduction of new vaccine (cm<sup>3</sup>)</b>													
<b>Increase in storage volume caused by introduction of new vaccine (m<sup>3</sup>)</b>													
<b>Percentage increase from introducing a new vaccine</b>													



---

# Annex 4:

## Calculating vaccine volume for cold storage

The method for estimating the vaccine storage volume for cold storage is essentially the same as that for transport. However, for cold storage there are two worksheets, one for the national and regional levels, which includes freezers and refrigerators, the other for the health centre level, where only refrigerators are used. The worksheet may be downloaded from the Internet at <http://www.who.int/vaccines/en/techdocs/worksheet.xls>.

For cold storage the grossing factor allows extra space for air circulation. This grossing factor is proportional to the storage volume, i.e. it increases as the storage volume increases.

At the national level it is usual for cold stores to be used. Here the grossing factor varies with the size of the room. Recommended values for cold stores are outlined in Table 5.

**Table 5: Grossing factors according to size of cold room**

Gross volume	5 m <sup>3</sup>	10 m <sup>3</sup>	20 m <sup>3</sup>	30 m <sup>3</sup>	40 m <sup>3</sup>
Grossing factor	2.1	2.4	2.9	3.0	3.0

Source: WHO/EPI/LHIS/96.03 (2002 revision in preparation).

Grossing factors for refrigerators and freezers vary considerably according to the type of equipment used. It is therefore difficult to give specific recommendations. As with cold boxes for transport, the grossing factor can be calculated by using the specifications quoted in the WHO/UNICEF *Product Information Sheets*. The manufacturer's gross volume, which is the internal volume of the refrigerator or freezer, should be divided by the vaccine storage capacity. An example of this calculation for a refrigerator specified in the *Product Information Sheets* is given in Table 6.

---

**Table 6: Calculation of refrigerator grossing factor**

Refrigerator and freezer PR 245 K/E kerosone and electric	
	Litres
Manufacturer's gross volume for refrigerator	107
Vaccine storage capacity	18
Grossing factor (gross volume/vaccine storage capacity)	5.9

**Worksheet 2a: Estimation of vaccine storage volume for cold rooms and refrigerators at national and provincial level**

Vaccine	No. of doses per vial	Packed volume per dose (cm <sup>3</sup> )	No. of doses per FIC	Vaccine wastage rate (%)	Wastage factor	Net vaccine storage volume per FIC (cm <sup>3</sup> )		Cold chain grossing factor	Total vaccine storage volume per FIC (cm <sup>3</sup> )		Annual number of live births	Total annual vaccine storage volume (cm <sup>3</sup> )		Annual supply interval	Vaccine storage volume per shipment (m <sup>3</sup> )	
						At+4°C	At-20°C		At+4°C	At-20°C		At+4°C	At-20°C			
Vaccines in existing schedule:	A	B	C	D	$E = \frac{1}{1-(D)}$	$F = B \times C \times E$	$G = B \times C \times E$	J	$K = F \times J$	$L = G \times J$	M	$N = K \times M$	$O = L \times M$	P	$Q = \frac{(N/P)}{1000\ 000}$	$R = \frac{(O/P)}{1000\ 000}$
<b>Total</b>																
Vaccines in new schedule:																
<b>Total</b>																
<b>Increase in storage volume caused by introduction of new vaccine (cm<sup>3</sup>)</b>																
<b>Increase in storage volume caused by introduction of new vaccine (m<sup>3</sup>)</b>																
<b>Percentage increase from introducing a new vaccine</b>																

**Worksheet 2b: Estimation of vaccine storage volume for refrigerators at service delivery level**

Vaccine	No. of doses per vial	Packed volume per dose (cm <sup>3</sup> )	No. of doses per FIC	Vaccine wastage rate (%)	Wastage factor	Net vaccine storage volume per FIC (cm <sup>3</sup> ) at +4°C	Cold chain grossing factor	Total vaccine storage volume per FIC (cm <sup>3</sup> ) at +4°C	Annual number of live births	Total annual vaccine storage volume (cm <sup>3</sup> ) at +4°C	Annual supply interval	Vaccine storage volume per shipment (m <sup>3</sup> ) at +4°C
	A	B	C	D	$E = \frac{1}{1-D}$	$F = B \times C \times E$	J	$K = F \times J$	M	$N = K \times M$	P	$Q = \frac{N/P}{1000\ 000}$
Vaccines in existing schedule:												
<b>Total</b>												
Vaccines in new schedule:												
<b>Total</b>												
<b>Increase in storage volume caused by introduction of new vaccine (cm<sup>3</sup>)</b>												
<b>Increase in storage volume caused by introduction of new vaccine (m<sup>3</sup>)</b>												
<b>Percentage increase from introducing a new vaccine</b>												

# Annex 5:

## Vaccine storage volumes, including primary packing (October 2001)

Vaccine product	Number of doses per vial	Packed volume per dose cm <sup>3</sup>	Source
BCG freeze-dried	10	1.0	WHO recommended maximum
BCG freeze-dried	20	1.0	WHO recommended maximum
DTP	10	3.0	WHO recommended maximum
DTP	20	2.5	WHO recommended maximum
DT for young children	10	3.0	WHO recommended maximum
DT for young children	20	2.5	WHO recommended maximum
Td for adults	10	3.0	WHO recommended maximum
Td for adults	20	2.5	WHO recommended maximum
TT for schoolchildren	10	3.0	WHO recommended maximum
TT for schoolchildren	20	2.5	WHO recommended maximum
TT for pregnant women	10	3.0	WHO recommended maximum
TT for pregnant women	20	2.5	WHO recommended maximum
TT for women of childbearing age (routine only)	10	3.0	WHO recommended maximum
TT for women of childbearing age (routine only)	20	2.5	WHO recommended maximum
Oral polio	10	2.5	WHO recommended maximum
Oral polio	20	1.5	WHO recommended maximum
Measles freeze-dried (w/o diluent)	1	9.3	Aventis Pasteur
Measles freeze-dried (w/o diluent)	10	3.0	WHO recommended maximum
MR freeze-dried (w/o diluent)	10	3.0	WHO recommended maximum
MMR freeze-dried (w/o diluent)	10	3.0	WHO recommended maximum
Yellow fever (w/o diluent)	10	3.7	Aventis Pasteur
Yellow fever (w/o diluent)	20	1.8	Aventis Pasteur
Yellow fever (w/o diluent)	10	1.2	Institut Pasteur de Dakar
Yellow fever (w/o diluent)	20	0.6	Institut Pasteur de Dakar
Meningococcal A/C	10	2.5	Aventis Pasteur
Meningococcal A/C	50	1.6	Aventis Pasteur

Vaccine product	Number of doses per vial	Packed volume per dose cm <sup>3</sup>	Source
Japanese encephalitis with diluent	1	60.0	Biken
Japanese encephalitis with diluent	10	15.0	Biken
Japanese encephalitis (w/o diluent)	10	8.1	Biken
HepB	1	14.9	Merck
HepB	6	2.7	Merck
HepB	1	9.7	GlaxoSmithKline
HepB	2	4.8	GlaxoSmithKline
HepB	10	2.3	GlaxoSmithKline
HepB	1	33.8	LG, Korea
HepB	10	2.6	LG, Korea
HepB	1	23.5	Green Cross Vaccines Cooperation
HepB	2	11.8	Green Cross Vaccines Cooperation
HepB	10	3.8	Green Cross Vaccines Cooperation
HepB UniJect™	1	24.6	P.T. Bio Farma (Persero)
Hib liquid	1	32.3	Chiron
Hib liquid	10	13.8	Chiron
Hib liquid	10	9.5	Wyeth
Hib freeze-dried w/o diluent	1	9.7	GlaxoSmithKline
Hib freeze-dried w/o diluent	2	4.8	GlaxoSmithKline
DTP–HepB (two separate vials packed together)	10	8.2	Green Cross Vaccines Cooperation
DTP–HepB + AD syringe (two separate vials packed together)	2	41.2	Green Cross Vaccines Cooperation
DTPa–HepB combined in syringe	1	99.0	GlaxoSmithKline
DTPw–HepB combined	1	9.7	GlaxoSmithKline
DTPw–HepB combined	2	4.8	GlaxoSmithKline
DTPw–HepB combined	10	3.0	GlaxoSmithKline
DTPw–Hib combined freeze-dried + AD syringe*	1	154.0	Aventis Pasteur
DTPw–Hib combined freeze-dried*	10	11.9	Aventis Pasteur
DTPw–Hib combined liquid	1	32.3	Chiron
DTPw–Hib combined liquid	10	13.8	Chiron
DTPw–HepB + Hib combined**	1	19.4	GlaxoSmithKline
DTPw–HepB + Hib combined**	2	9.7	GlaxoSmithKline
DTPw–HepB + Hib combined**	10	5.3	GlaxoSmithKline

\* One vial DTPw liquid + one vial Hib freeze-dried (Hib is reconstituted with DTP).

\*\* One vial DTP liquid + one vial Hib freeze-dried (Hib is reconstituted with DTP–HepB)

# Annex 6:

## Budget line items for disease surveillance

Budget line item	Subitems
Personnel (salaries/per diems)	<ul style="list-style-type: none"> <li>· Case investigators</li> <li>· Active surveillance officers / field epidemiologists</li> <li>· Data managers</li> <li>· Laboratory staff</li> </ul>
Workshops, meetings, training	<ul style="list-style-type: none"> <li>· National training/planning workshops</li> <li>· Subnational training/planning workshops</li> <li>· Training of case investigators and surveillance officers</li> <li>· Laboratory staff training</li> <li>· Coordination meetings</li> </ul>
Social mobilization	<ul style="list-style-type: none"> <li>· Clinician advocacy</li> <li>· Local meetings</li> </ul>
Equipment (capital costs)	<ul style="list-style-type: none"> <li>· Specimen carriers</li> <li>· Refrigerators/freezers</li> <li>· Cars, motorcycles, boats, bicycles</li> <li>· Laboratory equipment</li> <li>· Computer equipment</li> <li>· Communications and data transfer equipment</li> </ul>
Operations and supplies (recurrent costs)	<ul style="list-style-type: none"> <li>· Specimen kits</li> <li>· Specimen shippers</li> <li>· Laboratory consumables</li> <li>· Vehicle fuel</li> <li>· Vehicle maintenance (including spare parts)</li> <li>· Computer maintenance (including spare parts)</li> <li>· Communications equipment maintenance</li> <li>· Creation and distribution of standard forms and feedback</li> <li>· Materials and activities for social mobilization and advocacy</li> <li>· Ad hoc reimbursements for notifications</li> <li>· Freight costs of importing/transporting equipment</li> </ul>

Source: Hodge M, Haghgou M, Birmingham M. (2000)

---

# Annex 7:

## Using results in cost-effectiveness analysis

Cost-effectiveness analysis of public health interventions is performed in order to guide the allocation of resources. The aim is to inform decision-makers about the value for money to be expected from investment in certain interventions. One could, for instance, compare the cost per life-year saved as a consequence of introducing a new vaccine with that of investing in the expansion of tuberculosis treatment.

The estimation of the incremental costs of introducing a new vaccine is a crucial part of a cost-effectiveness analysis of the vaccine. Other cost data needed depend on the viewpoint of the analysis and on the details required. It may also be necessary to include the following types of data.

- Treatment costs saved as a result of the introduction of the vaccine: an estimate could be generated, including the public as well as the private health sector, depending on the viewpoint taken.
- Costs of adverse events following vaccination.
- Time and transport costs incurred by parents seeking vaccination.
- Time and transport costs saved by parents as a result of reduced illness attributable to vaccination.

The net costs of vaccine introduction should be estimated for the cost-effectiveness analysis. These are the costs of introducing the vaccine minus the savings attributable to vaccination, e.g. averted treatment costs.

However, cost data are only one side of the equation of a cost-effectiveness analysis. Evidence of the effectiveness of vaccination is a necessary foundation for the analysis. Without good effectiveness data a reliable result cannot be generated. Effectiveness data can be presented in various ways. A common intermediate outcome measure is the number of cases prevented, but since this does not indicate much about change in the health status of a population it cannot be used for comparison with other interventions. The final outcome measures may be deaths prevented or life-years gained. An outcome measure that includes morbidity as well as mortality, such as the quality-adjusted life-year or the disability-adjusted life-year, is generally preferred, but collecting the required data is difficult and time-consuming (Drummond, O'Brian, Stoddart and Torrance, 1997).

Depending on the measure of effectiveness that is chosen, the cost-effectiveness ratio can be expressed as cost per death prevented, cost per life-year saved, cost per disability-adjusted life-year gained, and so on.



---

# Annex 8:

## Forms for data collection

The following data collection forms are reproduced.

- A1. Capital costs: waste management
- A2. Capital costs: vehicles
- A3. Capital costs: cold chain storage
- A4. Other capital costs
- A5. Recurrent costs: vaccine supplies
- A6. Recurrent costs: supplies for waste management
- A7. Recurrent costs: supplies for disease surveillance
- A8. Recurrent costs: transport
- A9. Recurrent costs: cold chain storage
- A10. Recurrent costs: personnel

These forms can be downloaded from the Internet at <http://www.who.int/vaccines/en/techdocs/forms.xls>.

On each form the input should be described by type and as a unit of measure. The unit of measure might, for instance, be “each”, e.g. for cars, or “pack of 100”, e.g. for syringes. Each form has columns for financial costs and economic costs.

**Form A1. Capital costs: waste management**

Type of equipment	Unit of measure	Quantity Q	Unit costs P	Years of useful life L	Annualization factor F	Annualized costs	
						Financial (Q x P)/L	Economic (Q x P)/F
<b>Total</b>							

**Form A2. Capital costs: vehicles**

Type of vehicle	Unit of measure	Quantity Q	Unit costs P	Years of useful life L	Annualization factor F	Annualized costs	
						Financial (Q x P)/L	Economic (Q x P)/F
<b>Total</b>							

**Form A3. Capital costs: cold chain storage**

Type of equipment	Unit of measure	Quantity Q	Unit costs P	Years of useful life L	Annualization factor F	Annualized costs	
						Financial (Q x P)/L	Economic (Q x P)/F
<b>Total</b>							

**Form A4. Other capital costs**

Type of input	Unit of measure	Quantity Q	Unit costs P	Years of useful life L	Annualization factor F	Annualized costs	
						Financial (Q x P)/L	Economic (Q x P)/F
<b>Total</b>							

**Form A5. Recurrent costs: vaccine supplies**

Type of supply	Unit of measure	Quantity Q	Unit costs		Total costs	
			Financial P	Economic K	Financial Q x P	Economic Q x K
<b>Total</b>						

**Form A6. Recurrent costs: supplies for waste management**

Type of supply	Unit of measure	Quantity Q	Unit costs		Total costs	
			Financial P	Economic K	Financial Q x P	Economic Q x K
<b>Total</b>						

**Form A7. Recurrent costs: supplies for disease surveillance**

Type of supply	Unit of measure	Quantity Q	Unit costs		Total costs	
			Financial P	Economic K	Financial Q x P	Economic Q x K
<b>Total</b>						

**Form A8. Recurrent costs: transport**

Type of supply	Unit of measure	Quantity Q	Unit costs		Total costs	
			Financial P	Economic K	Financial Q x P	Economic Q x K
<b>Total</b>						

**Form A9. Recurrent costs: cold chain storage**

Type of supply	Unit of measure	Quantity Q	Unit costs			Total costs	
			Financial P	Economic K	Financial Q x P	Economic Q x K	
<b>Total</b>							

**Form A10. Recurrent costs: personnel**

Category of personnel	Quantity Q	Gross annual salary allowances		Costs of annual costs		Total annual		% allocation on new vaccine	
		Financial	Economic	Financial	Economic	Financial Q x G x A	Economic Q x S x L	Financial	Economic
<b>Total</b>									

---