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Financial requirements of immunisation programmes in developing countries: a 2004–2014 perspective☆

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Abstract

Vaccines are a key contributor to public health, especially in developing countries. Despite numerous demonstrations of the cost-effectiveness of immunisation, vaccines spending accounted for only 1.7% of the total pharmaceutical market in 2002, when UNICEF estimated that 34 million children were not reached by routine immunisation, most of them in developing countries.

Several international organizations or initiatives, like the Global Alliance for Vaccines and Immunisation (GAVI), have defined a long-term goal of universal immunisation in developing countries. There is an urgent need to estimate the financial resources required to meet this goal.

The objective of this study was to anticipate the funding needs for childhood immunisation in developing countries over the 2004–2014 period. The study scope includes all the 75 countries eligible for support from GAVI, and covers existing vaccines that are considered as a priority for GAVI (DTP (diphtheria, tetanus, pertussis), hepatitis B, *Haemophilus influenzae* type b (as a stand alone presentation or in combination with DTP) and yellow fever) as well as future vaccines (meningitis A and C, rotavirus, human papilloma virus (HPV), malaria, *Streptococcus pneumoniae* and tuberculosis) likely to be available within the 10-year period.

We developed a methodology to estimate the number of doses required, based on disease prevalence and incidence, target populations, introduction dates of new vaccines, coverage dynamics and dosing regimen. The introduction price and price evolution of vaccines over time were modelled, taking into account the type of vaccine, the expected return on investment from vaccine manufacturers and the competitive landscape. Non-vaccine costs (capital costs and non-vaccine recurrent costs) were estimated based on the number of people immunised and number of doses dispensed, using available case studies as a reference.

According to the optimal scenario that would consider the provision of all vaccines to all relevant developing countries as soon as they are available, funding requirements to cover the associated total costs over the 10-year period were estimated to be about US$ 30 billion.

Vaccines-related costs represent the largest share, with estimated costs of US$ 21 billion (among which 18 billion for new vaccines), the remaining needs being split between capital costs and other recurrent costs.

Accounting for the main imponderables (such as delay in vaccines launch compared to industry plans) as well as probable phasing of vaccine introduction in countries, the total costs of immunisation would be reduced to US$ 14–17 billion over the same period. Vaccines-related costs represent the largest share (US$ 7.1–9.3 billion, among which 4.3–6.5 billion for new vaccines).

This study advocates for the anticipation of the substantial financial resources needed to (a) purchase and introduce these vaccines in the developing countries in order to reduce the time lag between availability in industrialised and developing countries; and (b) stimulate vaccine researchers and manufacturers to continue research and development of much needed vaccines for the developing world.

Keywords: Immunisation; Developing countries; Financial requirements

Abbreviations: ADIP, accelerated development and introduction plans; CDC, centre for disease control and prevention; DTP, diphtheria, tetanus, pertussis; GAVI, global alliance for vaccines and immunisation; GNI, gross national income; HepB, hepatitis B; Hib, *Haemophilus influenzae* type b; HPV, human papilloma virus; NGO, non-governmental organisation; PAHO, Pan American Health Organization; UNICEF, United Nations Children's Fund; WHO, The World Health Organization

☆ The assumptions and resulting estimates as well as the opinions expressed herein are those of the authors and do not necessarily reflect the views of the organisations or their representatives interviewed.

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1. Introduction

Immunisation has been shown to be one of the most cost-effective contributors to public health improvement, especially for children in developing countries. This can be exemplified by the Global Polio Eradication Initiative. This program, lasting from 1998 to 2005, should protect an estimated 5 million children against paralysis [1]. In 2002 alone, the death of 35,000 children has been prevented. An assessment of the cost/benefit of polio eradication concluded that vaccination will pay for itself in the long-term, with financial savings estimated to be twice as high as the vaccination costs [2]. Another study has shown that at least an 80% reduction in measles-associated deaths has been obtained through vaccination [3]. Vaccination against *Haemophilus influenzae* type b (Hib) can lead to a 10-fold decrease of the annual incidence of Hib meningitis in children below 1 year [4].

Despite the effectiveness of vaccination, the spending on vaccines is small, since it represented 1.7% of the total pharmaceutical markets in monetary terms in 2002.

According to the Global Alliance for Vaccines and Immunisation, administration of all existing vaccines to all children in developing countries would save 3.0 million children's lives every year. UNICEF estimates that each year, 34 million children are not reached by routine immunisation, most of them in the Sub-Saharan Africa and South Asia regions, among the poorest in the world. Several international initiatives such as EPI (Expanded Programme on Immunisation) have been created to support better immunisation programmes in middle- and low-income countries. GAVI through its network of partners, which includes Governments, WHO, UNICEF, the World Bank, the Bill & Melinda Gates Foundation, Research Institutes, NGOs and the vaccine manufacturers, is becoming the leading entity supporting developing countries to improve and expand their immunisation efforts with technical assistance and financial support. Through its financial arm, the Vaccine Fund, GAVI has been quite active over the past 4 years supporting all countries with an annual gross national income (GNI) of less than US$ 1000 per capita that submit acceptable applications for support. GAVI also provides some support to China, India and Indonesia (although their GNI is above the established threshold of US$ 1000 per capita). GAVI through the Vaccine Fund provides grants to support national efforts to improve the quality and coverage of national immunisation programmes. GAVI also provides Hib, HepB and yellow fever vaccines to eligible countries to allow them to expand the range of diseases that they are protecting their children from. The Pan American Health Organization (PAHO) is another international organisation dedicated to improving the health and living standards of the people of the Americas. In the area of vaccination, it mainly focuses on procurement and vaccination policies.

These organisations have a long-term immunisation goal of expanding the use of existing vaccines which are currently underused, and of reducing delay in the introduction of new vaccines in developing countries.

However, to be in a position to meet this goal, they will have to anticipate the financial resources required.

The objective of this study was to estimate the funding needs for childhood immunisation in developing countries over the 10-year period 2004–2014.

The study scope includes all the 75 countries eligible for support from GAVI.

The study covers existing vaccines viewed by GAVI as a priority, namely diphtheria, tetanus, pertussis, hepatitis B, Hib (as a stand alone presentation or in combination with DTP) and yellow fever. Six future vaccines, to be introduced in the developing world within the 2004–2014 timeframe, have also been analysed. These vaccines are targeted against meningitis A and C, rotavirus, human papilloma virus, malaria, *S. pneumoniae* and tuberculosis. The study outcome will be the identification of the funding needs for immunisation of children below 13 years over the 2004–2014 period, in the GAVI-eligible countries.

2. Methods

Seven variable parameters and seven constant parameters have been considered to forecast the funding needs associated with the optimal fulfilment of immunisation against diseases included in the scope of the study.

2.1. Variable parameters

1. *Geography:* The GAVI-eligible countries selected for each disease analysis were based on incidence and prevalence as determined by international organisations such as the WHO, the U.S. CDC,[1] Institut Pasteur and the GAVI [5].
2. *Target population:* Surviving infants below one year of age were considered for all the diseases analysed except for HPV and malaria [6,7]. For HPV, the target population was defined as females between 10 and 12 years. For malaria, surviving infants and 1–4 years old disease-free children were considered [8,9].
3. *Vaccines launch dates:* Expected launch dates for new vaccines were provided by vaccine manufacturers, while expected availability to GAVI was estimated through interviews with international organisations. The current time lag between availability of a new vaccine in the Western World and in developing countries is at best 4–5 years. However, there is now hope for a reduction of this delay through better collaboration among all stakeholders. Better demand forecasting and supply planning of the quantities required, an earlier building of manufacturing capacity and a more efficient negotiating process have been observed over the recent years. This paradigm shift can be exemplified by meningococcal meningitis and

[1] Centres for Disease Control & Prevention.

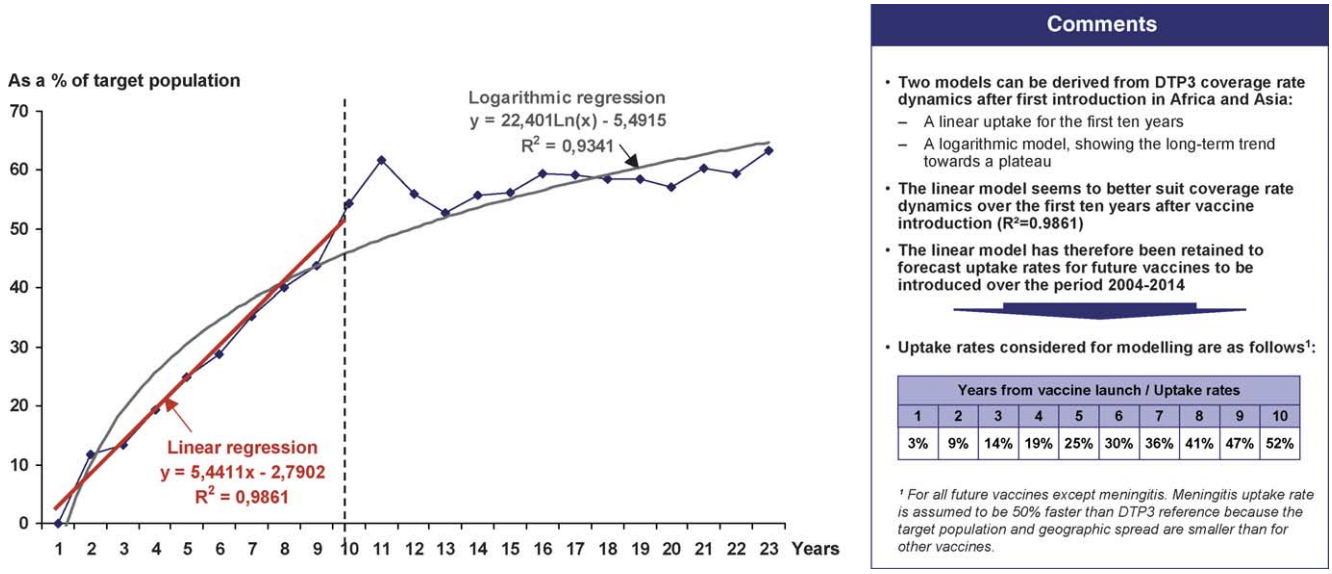

Fig. 1. Modelling of coverage rate dynamics for future vaccines (2004–2014), after WHO and UNICEF estimates for DTP3 coverage over time.

rotavirus vaccines, the two vaccines within the study scope closest to being introduced in the market:

a. Conjugated meningococcal meningitis vaccine is being developed specifically for "meningitis belt" countries, in close collaboration between the WHO and the vaccine industry.
b. Rotavirus vaccine is supported by an Accelerated Development and Introduction Plan (ADIP) of GAVI, whose mandate is to accelerate the introduction of a rotavirus vaccine in developing countries, together with the early building of manufacturing capacities.

As a result, these vaccines should have a reduced introduction time lag (1 year for meningitis and 2 years for rotavirus) in GAVI-supported countries. The experience gained through efforts to accelerate the availability and the use of these vaccines in developing countries is important not only for the introduction of these products, but also for the introduction of future vaccines.

4. *Coverage dynamics:* For existing vaccines, the current coverage was taken into account and the target coverage retained for the modelling was based on the goal as expressed by GAVI and the concerned countries. The uptake rates for future vaccines have been derived from the DTP3 coverage rates in Africa and Asia, over the first 10 years of commercialisation (Fig. 1). However, for meningitis, the uptake rate is assumed to be 50% faster than the DTP3 model, due to the well-documented recognition of the severity of the disease by families in the region and their very positive experiences with the polysaccharide vaccines.
5. *Dosing regimen:* For primary immunisation, two or three doses were considered, while booster doses and timelines were modulated depending on vaccine characteristics (Table 1).
6. *Price of vaccines:* Introduction price for future vaccines and modelling of price evolution over time for existing and future vaccines were estimated after interviews with vaccine manufacturers and funding organisations. The impact of vaccine type, the expected return on investment and the competitive landscape have been considered to estimate prices of vaccines:
   a. Combined vaccines are usually more expensive to purchase than monovalent ones. For modelling purposes, combinations were only considered for existing vaccines, and marginal prices were applied to future vaccines, assuming they would not be combined.
   b. The expected return on investment and profitability level from the industry have been maintained as of today. However, the increased complexity and

Table 1
Dosing regimen of existing and future vaccines

	DTP/HepB/Hib[a]	Yellow fever	MenA/C	Rotavirus	Malaria	HPV	*S. pneumoniae*	Tuberculosis
Age target	Infants	Infants	Infants	Infants	Infants, children 1–4 years	Females 10–12 years	Infants	Infants
Number of doses	3	1	3	2	3	3	3	3
Boosters	–	–	–	–	2	–	–	1
Timing boosters	–	–	–	–	+5 years	–	–	+10 years

[a] Single antigen or combinations of antigens.

longer timelines to develop new vaccines, along with increased upfront investments required to build capacity, will impact price levels. This was captured into the higher price levels assumed for future vaccines.

c. Competitive intensity is also expected to increase over time with the emergence of local manufacturers like the Serum Institute of India and BioFarma from Indonesia, leading to price adjustments.

We can assume that the future price of *S. pneumoniae* vaccine would be about US$ 10 per dose. A mark-up of 20%, to account for the increased complexity of future vaccines to be launched after 2006 has been applied. Thus, the introduction price for new vaccines within the scope of the study (excluding meningitis) has been set at US$ 12, for developing countries.

It is assumed that meningitis vaccine will be sold in combination with existing DTP, hepatitis B and Hib vaccines in a hexavalent (DTP-HepB-Hib-men) form. Hib vaccine has been retained as a reference for meningitis pricing, considering its recent launch, its comparable complexity and its commercialisation in combination with DTP and hepatitis B. The estimated introduction price of meningitis vaccine for developing countries has been determined by applying a 20% mark-up to the Hib vaccine sold at the current lowest price of US$ 2.34 per dose, according to UNICEF. The mark-up reflects the more complex combinations expected for meningitis. The change over time of the price of hepatitis B vaccine has been used as a reference for price modelling of future vaccines.

7. *Non-vaccine costs:* Total costs of providing immunisation services are typically split between capital (or investment) costs and recurrent costs [10–12]. Capital costs include share of health facilities, vehicles, major equipment (cold chain, etc.) and long-term training used for immunisation. Recurrent costs include personnel, vaccine supplies, transportation, maintenance and overhead, short-term training as well as information, education and communication. When expanding the scope of immunisation, capital and recurrent costs vary with the number of people immunised and/or the number of doses dispensed. A unit dollar cost per person immunised and per dose dispensed is allocated to each type of cost [10–12], and used to derive the non-vaccine costs.

No discounting of figures has been applied.

Based on discussions with the WHO and the Overseas Development Institute (a UK-based non-governmental organization), adjustments were made to account for the fact that:

a. When the coverage rate exceeds 85%, the unit cost to reach one additional person or dispense one additional dose doubles, due to difficulty of access, distance, etc.
b. Existing local health infrastructures do not run at full capacity until DTP3 coverage reaches 60%, and therefore personnel and capital costs (except equipment-related costs) do not increase until this threshold is reached.

2.2. Pre-determined parameters

1. *Efficacy of vaccines:* The analysed vaccines are supposed to be efficacious over time in 100% of cases. Therefore, it is considered that no additional vaccine is dispensed beyond the recommended standard vaccination schedule.
2. *Compliance to vaccination schedules:* Compliance to primary vaccine regimen is captured into uptake and coverage rates, while compliance to booster schemes is estimated at 10%.
3. *Vaccine wastage:* It is assumed that the average wastage set at 20% is constant over years.
4. *Vaccine buffer:* At each change of antigen, 25% additional quantities (including wastage) are added in the first year of vaccine introduction to account for the creation of an inventory to build buffer capacity.
5. *Production capacity:* No constraint of production capacity has been assumed over the period 2004–2014. Thus, availability and prices of vaccines have not been impacted by this factor.
6. *Reliability of logistics:* No logistics issues have been considered. Vaccines are assumed to be available where they are needed, on time and on required quantities.
7. *Attrition rate:* The attrition rate, which captures the probability for a product in development not to reach the market, has been kept constant at 0%.

2.3. Alternative scenarios

In practical terms, the optimal fulfilment of immunisation ambition for developing countries might be altered by a set of factors depending on vaccine manufacturers R&D process, GAVI, as well as developing countries themselves.

To estimate the combined effects of these factors on the financial requirements, alternative scenarios have been developed based on the following parameters:

1. *Launch date of future vaccines:* Due to the inherent uncertainty of R&D activities, manufacturers planned launch date might experience some delay (the farther the launch date away, the higher the risk of delay). Thus, a 1–2 years delay has been added to manufacturer's planned launch date for vaccines expected to be introduced after 2008 (malaria, tuberculosis and *S. pneumoniae*).
2. *Phasing of introduction of future vaccines in GAVI countries:* The 75 countries eligible for support from GAVI have been segmented into "early", "medium" and "late" adopters of new vaccines, based on their rate of adoption of Hib antigen in their vaccination calendar. "Early" adopters are assumed to introduce future vaccines as soon as they are available from GAVI, "medium" adopters would introduce vaccines with a 1–2 years delay, and "late" adopters with a 2–3 years delay.

Vaccines prices have not been changed since they represent the best estimate from the vaccine industry at this point, and they depend on further discussion with international organisations, payers, NGOs and governments, which are not in the scope of the current study.

3. Results

3.1. Estimated population immunised (2004–2014)

The estimated number of persons to be immunised is derived from the number of people in the target population and the expected immunisation coverage. Assuming that the target population for immunisation is composed of females between 10 and 12 years for HPV, surviving infants and disease-free children between 1 and 4 years for malaria, and surviving infants for all the other analysed vaccines, the number of immunised people over the 2004–2014 period should reach 1046 million in the optimal scenario (Fig. 2). 109 million females should be vaccinated against HPV, 117 million children against malaria and 820 million infants against all other selected vaccines (i.e. DTP/ HepB/Hib combinations, yellow fever, meningitis, rotavirus, malaria, tuberculosis, *S. pneumoniae*).

Under the alternative scenarios, the total number of immunised people should reach 864–893 million (Table 2).

3.2. Estimated number of doses dispensed (2004–2014)

The number of doses is derived from the target population, the target coverage rate and dosing regimen (primary course and boosters) for each of the vaccines. Assuming that each person can receive several immunisations with different vaccines, the cumulated number of doses to be dispensed over the period 2004–2014 amounts to 7095 million (Fig. 3).

DTP/hepB/Hib vaccines in all presentations (tri-, tetra- or penta-valent) account for 71% of the cumulated doses dispensed over 10 years, due to already existing and rapidly growing coverage rates. In 2014, an equal quantity of existing and future vaccines will be administered.

Under the alternative scenarios, the cumulated number of doses amounts to 5780–5992 million (Table 2).

3.3. Total estimated cost of immunisation (2004–2014)

To achieve the immunisation of the people for the countries and diseases selected by the GAVI over the 2004–2014 period, a cumulated sum of US$ 30 billion would be required in the optimal scenario (Fig. 4). Three distinctive periods can be identified, based on the costs associated with new vaccines availability:

a. During the first period (2004–2005), no new vaccine is expected and the total immunisation costs would average US$ 584 million per annum, as a result of the increased coverage rates achieved with existing vaccines.
b. The second period (2006–2010) would see the arrival of four new vaccines against meningitis, rotavirus, malaria for children between 1 and 4 years and HPV in adolescent females. During this period the annual cost of immunisation should show a dramatic increase from US$ 772 million in 2006 to US$ 2660 million in 2010, mainly due to the introduction of these new vaccines.
c. The last period (2011–2014) would be marked by the introduction of vaccines against *S. pneumoniae*, malaria for infants and tuberculosis. The annual cost for total immunisation is expected to double from US$ 3636 million in 2011 to US$ 7024 in 2014. As for the second period, the further cost increase of this third period would result from the combined impact of new vaccines introduction

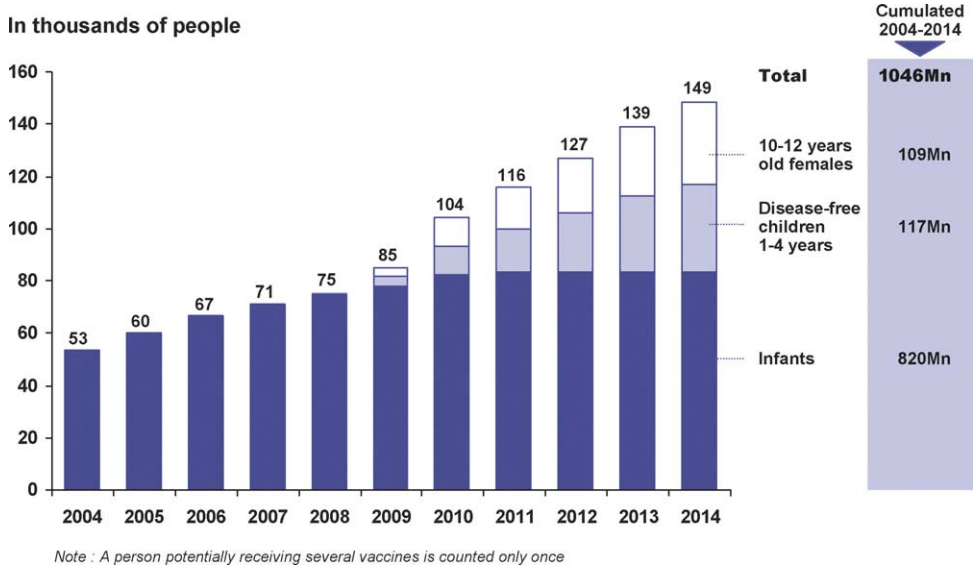

Fig. 2. Number of people immunised by population segment in countries eligible for GAVI support (2004–2014) (optimal scenario).

Table 2
Compared results between the optimistic and the alternative scenarios

	Optimal scenario (%)	Alternative scenario a (%)	Alternative scenario b (%)
Cumulated number of people immunised (million)	**1046 (100)**	**893 (100)**	**864 (100)**
Infants	820 (79)	820 (92)	820 (95)
Children 1–4 years old	117 (11)	40 (5)	26 (3)
Females 10–12 years old	109 (10)	33 (3)	18 (2)
Cumulated number of doses (million)	**7095 (100)**	**5992 (100)**	**5780 (100)**
Existing vaccines	5308 (75)	5308 (89)	5308 (92)
Future vaccines	1787 (25)	684 (11)	472 (8)
Cumulated costs (US$ billion)	**29.6 (100)**	**16.7 (100)**	**14.2 (100)**
Total costs			
Vaccines	20.9 (71)	9.3 (56)	7.1 (50)
Other recurrent	7.6 (26)	6.4 (38)	6.2 (44)
Capital	1.1 (3)	1.0 (6)	0.9 (6)
Vaccines costs	**20.9 (100)**	**9.3 (100)**	**7.1 (100)**
Existing	2.8 (13)	2.8 (30)	2.8 (40)
Future	18.1 (87)	6.5 (70)	4.3 (60)

Comments

Optimal scenario: vaccines are introduced in all the relevant countries at the same time, as soon as they are available to GAVI

Alternative scenario a:
One-year delay in vaccines launch compared to manufacturer planned date for malaria, *S. pneumoniae* and tuberculosis
"Late" adopters countries introduce vaccines two years after launch, "medium" adopters one year

Alternative scenario b:
Two-year delay in vaccines launch compared to manufacturer planned date for malaria, *S. pneumoniae* and tuberculosis
"Late" adopters countries introduce vaccines three years after launch, "medium" adopters two years

Most of the decrease in total costs between optimistic and alternative scenarios is attributable to vaccines cost, due to the segmentation as "late" adopters of countries with very large population (e.g. China, India, Indonesia, Bangladesh, Nigeria and Pakistan which combined represent 65% of infants)

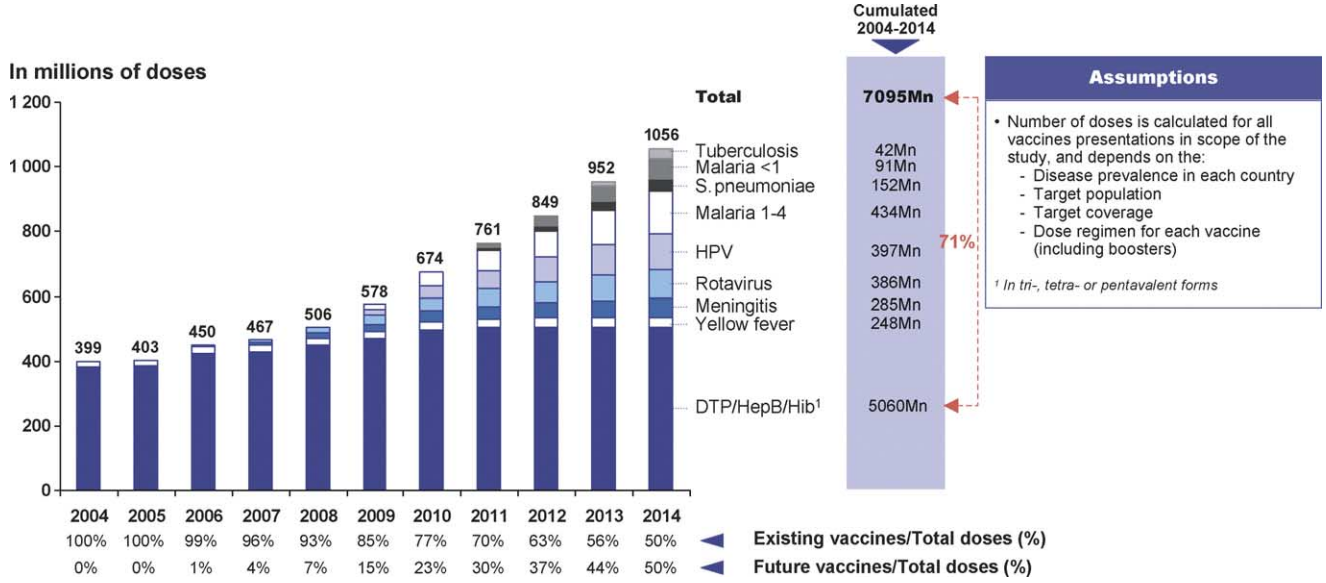

Fig. 3. Estimated number of doses by type of current and future vaccines for immunisation of people in countries eligible for GAVI support (2004–2014) (optimal scenario).

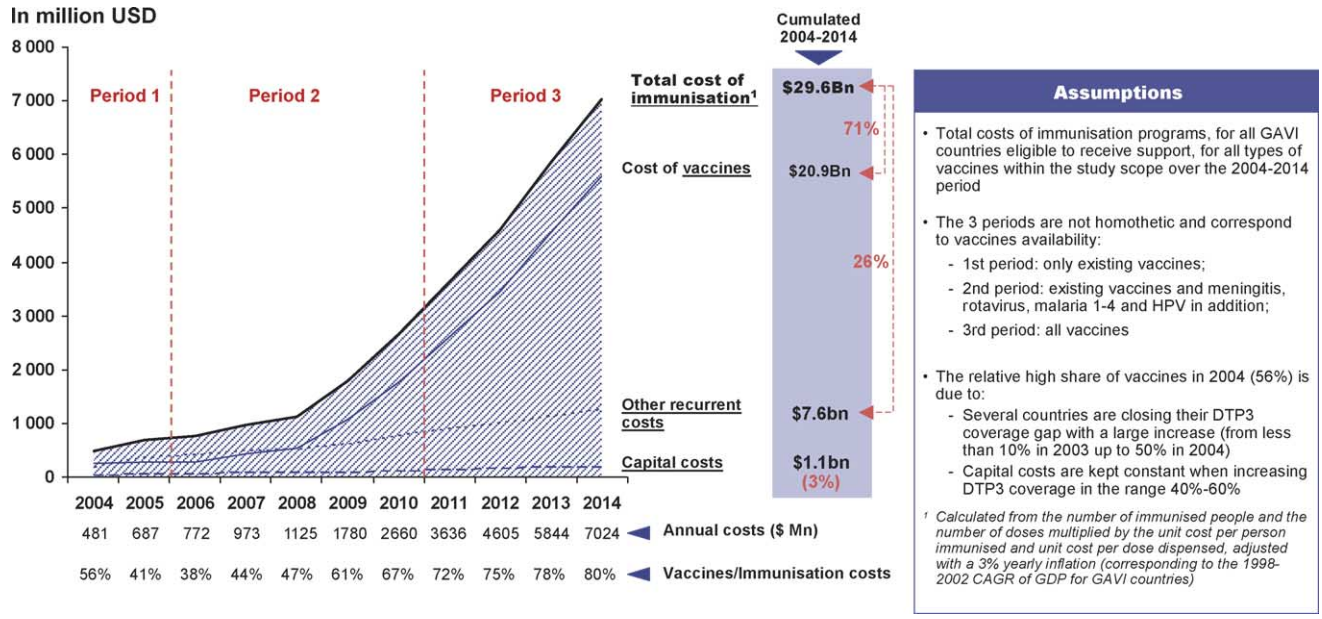

Fig. 4. Total cost estimates for immunisation of people in countries eligible for GAVI support (2004–2014) (optimal scenario).

and expansion, as well as from higher coverage rates for existing vaccines in all 75 countries.

The break-down of total immunisation costs shows that 71% of the cumulated costs are associated to purchase of existing and future vaccines per se (i.e. US$ 20.9 billion), 26% to other recurrent costs (i.e. US$ 7.6 billion) and 3% to capital costs (US$ 1.1 billion). The weight of vaccines in total immunisation costs would decrease between 2004 and 2005 from an unusual high rate of 56% in 2004 to 41% in 2005. This is due to the fact that:

- Several countries are closing their DTP3 coverage gap between 2003 and 2004 with a large increase in vaccination rate (from less than 10% in 2003 to 50% in 2004). This higher vaccination rate is achieved with existing health infrastructures, and therefore explains the relatively high share of vaccines in the total immunisation costs in 2004.
- From 2005 onwards, the increased vaccination coverage with existing vaccines will require additional investment in health infrastructures and other non-vaccine support, and will explain a smaller relative share of vaccines in total immunisation costs.

From 2006 to 2014, the share of vaccines in total immunisation costs would grow from 38 to 80%. This increase is associated with the introduction and increased coverage of several new vaccines, more complex and more expensive, without a proportionate inflation of other recurrent costs and capital costs.

Future vaccines that are not expected before 2006 would become the main cost driver after 2007 (Fig. 5). They should represent over the 2004–2014 period approximately 85% (US$ 18.1 billion) of the total vaccine costs. The weight of existing vaccines should not account for more than 4% of total vaccine costs in 2014. Within the existing vaccines, which should cost US$ 2.8 billion over the 2004–2014 period, the pentavalent combination (DTP, HepB and Hib) alone should account for 46%. For future vaccines, malaria, HPV and rotavirus would account for 83% of the total costs, i.e. approximately US$ 15.0 billion out of US$ 18.1 billion.

Under the alternative scenarios, the total cumulated sum of US$ 14.2–16.7 billion would be required for immunisation programmes (Table 2). This total amount can be further broken down into vaccines costs per se (50–56% of total), other recurrent costs (38–44%) and capital costs (6%).

If China, India and Indonesia were excluded from the scope, the 2004–2014 cumulated vaccine costs related to immunisation of the remaining 72 GAVI countries would decrease from US$ 20.9 billion to US$ 11.5 billion (respectively, from US$ 9.3 billion to US$ 6.1 billion under scenario a and from US$ 7.1 billion to US$ 5.1 billion under scenario b). Besides, restricting immunisation to epidemiological priorities in terms of diseases and countries would reduce the vaccine costs from US$ 20.9 billion to US$ 9.7 billion over the same period (respectively, from US$ 9.3 billion to US$ 6.3 billion and from US$ 7.1 billion to US$ 5.9 billion under the alternative scenarios). Epidemiological priorities have been defined as follows:

- All the diseases initially selected for the purpose of this study, but HPV for which the vaccination has been considered as a second priority.
- All countries eligible to receive support for DTP, HepB and Hib vaccines.
- For yellow fever, countries already “approved” and classified as “high risk” by GAVI.

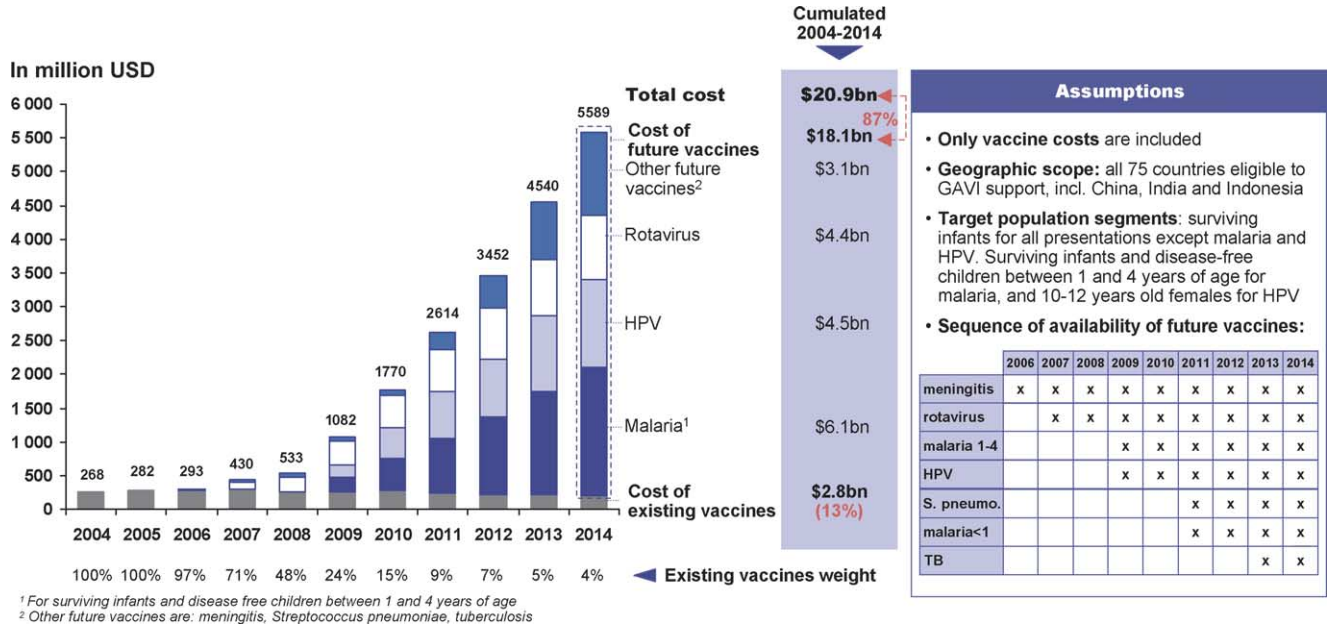

Fig. 5. Breakdown of existing and future vaccine costs for immunisation of people in countries eligible for GAVI support (2004–2014) (optimal scenario).

- For rotavirus, all the prevalent countries [13].
- Only the 22 countries forming the "meningitis belt" are included in the epidemiological priorities [5].
- Countries with a number of malaria cases equal to or above 5% of the overall population are included [9].
- All countries with tuberculosis prevalence are included [14].
- For *S. pneumoniae*, countries are included if the proportion of children dying from low acute respiratory infections (ARI) exceeds 20% [15].

4. Discussion

While vaccines remain one of the most cost-effective ways to prevent serious illness and death, the world still does not enjoy the full benefits of immunisation. Progress has been made by international organizations such as PAHO, WHO, UNICEF, GAVI/The Vaccine Fund and NGOs in supporting national efforts to increase the uptake of existing vaccines. However, there is still significant work to be done. For instance, the anticipated financial resources expected to be raised by the Vaccine Fund during the 10-year period 2004–2014 vary from a cumulated amount of US$ 2.6 billion in the worse case to US$ 5.3 billion in the best case, which have to be compared to the US$ 14–30 billion funding needs for total immunisation as shown by this study.

Funds will be needed for eligible GAVI countries that have not yet introduced hepatitis B, Hib or yellow fever (the three vaccines eligible to be purchased by GAVI). Additional funds will, no doubt, be needed for countries that have introduced existing vaccines, but that will not be able to fully pay for the vaccines from their own national budgets (our study shows that vaccines costs over 10 years for existing vaccines amount to approximately US$ 3 billion).

The historical evolution of the vaccine market shows it took between 15 and 20 years for a vaccine introduced in the developed world to begin reaching the developing world. For vaccines developed for diseases prevalent in the developing world, with little to no market in the developed world, this lag time could be reduced if the appropriate resources are made available from the public sector. This can be exemplified by the meningitis vaccine developed for "meningitis belt" countries and that will become available in 2006.

The international public health community has been urging the vaccine industry to research and develop vaccines for a number of diseases that are prevalent in the developing world. That research and development is now occurring for meningitis, rotavirus, malaria, HPV, tuberculosis and *S. pneumoniae*, and the corresponding vaccines should be ready for introduction in the developing world between 2006 and 2014.

Those vaccines that will have small market in the Western World will be developed, registered and launched first in developing countries where the need is the greatest. For other vaccines that have markets in both developed and developing countries, the strategy will be to launch them simultaneously in both worlds.

The international organizations, other members of the donor community, and the public health community have not focused on the amount of resources that will be needed to introduce and purchase these new vaccines. It is not part of their mandate to analyze the financial requirements associated with the provision of these vaccines, which will be a critical success factor in the uptake of these new vaccines.

This study shows that the 2004–2014 funding requirements associated to future vaccines are in the range of US$ 4–18 billion. In total, the amount needed to continue the purchase of existing vaccines and of the new vaccines over the period 2004–2014 is approximately US$ 7–21 billion for vaccines, and US$ 14–30 billion for total immunisation costs (Table 2). As early as 2008, the annual funds required for immunisation are estimated at US$ 1 billion, and should reach more than US$ 7 billion in 2014 (respectively, US$ 871 million in 2008 and US$ 3.1 billion in 2014 under the alternative scenarios).

If the entire international public health and donor communities do not anticipate these financial requirements and do not develop new strategies to raise funds, the delay between vaccine availability and launch in the developing world will not be reduced. Another important issue will be to convince the vaccine industry to keep investing in research and development of vaccines especially needed in the developing world.

Segmentation of 75 GAVI countries based on the rate of adoption of Hib antigen

- *"Early" adopters:* Benin, Bolivia, Burundi, Cuba, Gambia, Ghana, Guyana, Honduras, Kenya, Malawi, Mali, Mongolia, Nicaragua, Rwanda, Senegal, Uganda, Yemen, Zambia
- *"Medium" adopters:* Bhutan, Burkina Faso, Côte d'Ivoire, Eritrea, Lesotho, Madagascar, Nepal, Sudan, Tanzania, Vietnam, Zimbabwe
- *"Late" adopters:* Afghanistan, Albania, Angola, Armenia, Azerbaijan, Bangladesh, Bosnia & Herzegovina, Cambodia, Cameroon, Central African Republic, Chad, China, Comoros Island, Congo Democratic Republic, Congo Republic, Djibouti, Ethiopia, Georgia, Guinea, Guinea-Bissau, Haiti, India, Indonesia, Kyrgyztan, Laos, Liberia, Mauritania, Moldavia, Mozambique, Myanmar, Niger, Nigeria, North Korea, Pakistan, Papua New Guinea, Sao Thomé, Sierra Leone, Solomon Island, Somalia, Sri Lanka, Tajikistan, Timor Leste, Togo, Turkmenistan, Ukraine, Uzbekistan

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