

Cost analysis of post-polio certification immunization policies

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Objective An analysis was conducted to estimate the costs of different potential post-polio certification immunization policies currently under consideration, with the objective of providing this information to policy-makers.

Methods We analysed three global policy options: *continued use of oral poliovirus vaccine (OPV)*; *OPV cessation with optional inactivated poliovirus vaccine (IPV)*; and *OPV cessation with universal IPV*. Assumptions were made on future immunization policy decisions taken by low-, middle-, and high-income countries. We estimated the financial costs of each immunization policy, the number of vaccine-associated paralytic poliomyelitis (VAPP) cases, and the global costs of maintaining an outbreak response capacity. The financial costs of each immunization policy were based on estimates of the cost of polio vaccine, its administration, and coverage projections. The costs of maintaining outbreak response capacity include those associated with developing and maintaining a vaccine stockpile in addition to laboratory and epidemiological surveillance. We used the period 2005–20 as the time frame for the analysis.

Findings *OPV cessation with optional IPV*, at an estimated cost of US\$ 20 412 million, was the least costly option. The global cost of outbreak response capacity was estimated to be US\$ 1320 million during 2005–20. The policy option *continued use of OPV* resulted in the highest number of VAPP cases. *OPV cessation with universal IPV* had the highest financial costs, but it also had the least number of VAPP cases. Sensitivity analyses showed that global costs were sensitive to assumptions on the cost of the vaccine. Analysis also showed that if the price per dose of IPV was reduced to US\$ 0.50 for low-income countries, the cost of *OPV cessation with universal IPV* would be the same as the costs of *continued use of OPV*.

Conclusion Projections on the vaccine price per dose and future coverage rates were major drivers of the global costs of post-certification polio immunization. The break-even price of switching to IPV compared with continuing with OPV immunizations is US\$ 0.50 per dose of IPV. However, this does not account for the cost of vaccine-derived poliovirus cases resulting from the continued use of OPV. In addition to financial costs, risk assessments related to the re-emergence of polio will be major determinants of policy decisions.

Keywords Poliovirus vaccine, Oral/economics; Poliovirus vaccine, Inactivated/economics; Poliomyelitis/chemically induced; Certification; Immunization programs/economics; Disease outbreaks/economics; Policy making; Costs and cost analysis (source: MeSH, NLM).

Mots clés Vaccin antipoliomyélique Sabin/économie; Vaccin antipoliomyélique inactif/économie; Poliomyélite antérieure aiguë/induit chimiquement; Certification; Programmes de vaccination/économie; Epidémie/ économie; Choix d'une politique; Coût et analyse coût (source: MeSH, INSERM).

Palabras clave Vacuna antipolio oral/economía; Vacuna antipolio de virus inactivados/economía; Poliomiéltis/inducida químicamente; Certificación; Programas de inmunización/economía; Brotes de enfermedades /economía; Formulación de políticas; Costos y análisis de costo (fuente: DeCS, BIREME).

الكلمات المفتاحية: لقاح شلل الأطفال، اللقاح الفموي لشلل الأطفال، اقتصاديات إعطاء لقاح شلل الأطفال، اقتصاديات إعطاء اللقاح المعطل لشلل الأطفال، اللقاح المعطل لشلل الأطفال، اقتصاديات إعطاء اللقاح المعطل لشلل الأطفال؛ شلل الأطفال المحرض كيميائياً؛ الإسهاد؛ برامج التمنيع، اقتصاديات برامج التمنيع؛ فاشيات المرض، اقتصاديات فاشيات المرض؛ رسم السياسات؛ التكاليف، تحليل التكاليف.

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Voir page 14 le résumé en français. En la página 14 figura un resumen en español.

يمكن الاطلاع على الملخص بالعربية في صفحة 15

Introduction

Since the 1988 World Health Assembly resolution to eradicate polio globally, the incidence of polio has been reduced dramatically. In 2003, there were approximately 2000 reported cases world-wide and polio was endemic in only seven countries (Afghanistan, Egypt, India, Niger, Nigeria, Pakistan, and Somalia). As the achievement and certification of polio eradication draws near, WHO is evaluating potential post-certification immunization policies. At the beginning of the initiative, it was assumed that

polio vaccination would simply be withdrawn after certification of polio eradication followed by the accrual of financial benefits resulting from ceasing vaccination. Over the past decade newly identified oral poliovirus vaccine (OPV) risks such as circulating vaccine-derived polioviruses (cVDPVs) and rare chronic excretors of poliovirus, containment concerns, and the perceived bioterrorism threat have led to a scientific and economic reassessment of potential post-certification immunization policies. Although countries will ultimately make their own immunization policy decisions after careful assessment of their own costs,

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risks, and benefits, it is likely that they (particularly developing countries) will be greatly influenced by global policies recommended by WHO.

We estimated the global costs associated with immunization policies currently being considered: *continue OPV*, *OPV cessation with optional IPV*, and *universal inactivated poliovirus vaccine (IPV) (1)*. The costs of each policy are based on the total financial programme costs and the health costs, which we have limited to the number of cases of vaccine-associated paralytic poliomyelitis (VAPP). The global policy costs presented are meant as an aid for comparing the policies on a global scale. A comprehensive research agenda is being implemented to carefully assess the risks associated with these policies, but this is beyond the scope of our paper.

Methods and assumptions

This paper focuses on estimating the global costs of implementing each immunization policy, maintaining surveillance at current levels, and developing a vaccine stockpile. The costs of an outbreak were not included in this analysis (2). The costs of immunization were estimated by projecting vaccination coverage levels and the costs of the vaccine and its administration. We have included the number of projected VAPP cases under each policy scenario as a health cost and projected outbreak response capacity costs to include the current cost of maintaining epidemiological and laboratory surveillance and the cost of a vaccine stockpile. Vaccination coverage levels and labour costs vary for all countries. In addition, countries vary in their current polio immunization policies, and we have assumed that countries will make their own policy decision for each global policy recommendation. Policy assumptions for high-, middle-, and low-income countries were made on the basis of WHO projections on vaccine demand (H. Everts, C. Maher, personal communication, 2002). We categorized the country decisions by economic status using World Bank classifications (low income gross national income per capita (GNI), US\$ 735 or lower; middle income GNI, US\$ 736–9075; high income GNI, US\$ 9,076 or higher) (3). For example, some high-income countries, such as the United States, have already switched to IPV to avoid the risk of VAPP associated with OPV. Therefore, we have assumed that by the time of certification, high-income countries will switch to IPV regardless of the global policy recommendation. We have assumed that middle-income countries will gradually switch to IPV after certification and low-income countries will follow the global policy recommendation. Countries with very low coverage (below 70%) and that are recently endemic with polio were assumed to provide routine OPV and periodic supplemental vaccination by conducting national immunization days (NIDs) until 2010. Costs were estimated for all countries according to income groupings. These stratified cost estimates were then aggregated to estimate the global costs. The policy options and assumed scenarios analysed are given in Table 1. Table 2 lists the parameters used in the analysis.

Vaccine and delivery cost

Estimates of cost per dose include the costs of the vaccine and its delivery. Delivery costs were limited to labour, injection equipment, and operational costs of NIDs. Per-dose costs of OPV and

autodisable syringes were based on information from the United Nations Children's Fund (UNICEF) Supply Division. The price per dose of OPV used in this analysis was US\$ 0.10 and a syringe was US\$ 0.06 (4). The price per dose of IPV currently ranges from US\$ 2.50 (single antigen) to US\$ 53.00 (combination vaccine) (5). For the present analysis, the price per dose of IPV was projected at US\$ 2.00 for low-income countries, US\$ 5.00 for middle-income countries, and US\$ 10.00 for high-income countries^a. As manufacturers increase IPV production capacity and supply, there may be gains in technical efficiency leading to a decrease in price per dose over time. Also, with an increase in the number of doses sold, producers may be willing to lower their vaccine price because the loss in profits from the price reduction may be compensated for by the profits gained from the increase in sales volume. (This was seen in the case of the Hib vaccine in the Latin American market (6).)

Labour costs were based on the average time needed to administer OPV and IPV through routine vaccination programmes and OPV through mass campaigns, and on the average wage of health care workers by income category. Wage information on health care workers was taken from the International Labour Organization's statistical database (7). In addition, a recent study by WHO estimated wage costs for volunteers who participate in mass immunization campaigns (8). The wage per hour for a low-income country was assumed to be US\$ 0.30, US\$ 1.50 for a middle-income country, and US\$ 15.00 for a high-income country. The time it takes to administer an oral vaccine was estimated to be 30 seconds to 1 minute, and for an injection, 3–4 minutes; this translates to an average of 80 children per hour for an oral vaccine and 17 children per hour for an injection. In addition, the WHO Supplemental Immunization Activities guide estimates that a vaccinator should see at least 250 children per NID (9), which translates to 31 children per hour. This number tends to be lower than the field reports, but it may be the average, given that house-to-house immunization activities are also conducted. The operations cost per dose based on current WHO financial requirement reports was estimated to be between US\$ 0.14 and US\$ 0.40 (10).

The number of doses for routine OPV or IPV immunization was assumed to be three doses and for NIDs, two doses. A wastage factor of 1.2 was applied for OPV; no wastage calculations were estimated for IPV because we assumed that single-dose vials would be used. Assumptions on coverage were based on projections for two time periods, 2005–10 and 2011–20 (11). Coverage for low-income countries was assumed to increase in the second time period.

VAPP cases

The cost of adverse events also needs to be considered — that is, the occurrence of VAPP cases for OPV and, in the case of IPV, adverse events related to injection safety. This paper estimates the projected number of VAPP cases, but not the monetary costs, for each policy, as policy-makers will need to incorporate the health costs of adverse events related to vaccines in their decision-making. The occurrence of VAPP ranges from one case per 4.1 million doses in India to one case in 1.4 million doses in England and Wales (12, 13). WHO currently estimates the global burden of VAPP cases to be two to four per million birth cohort, which currently translates to 250–500 cases per year (14).

^a The assumed price for IPV can also be considered as the increase in price for including IPV into a combination vaccine.

Table 1. Description of potential post-polio eradication immunization policies

Policy option	Assumed scenario
Continued use of oral poliovirus vaccine (OPV)	<ul style="list-style-type: none"> • Low-income countries continue routine OPV • Periodic (every 4 years) pulse immunizations in low-income countries • Middle-income countries gradually switch to inactivated poliovirus vaccine (IPV) between 2006 and 2008 • High-income countries switch to IPV by 2005
OPV cessation with optional IPV	<ul style="list-style-type: none"> • Low-income countries stop all polio immunization in 2011, and rely on “surveillance and response” • Pulse immunizations in low-income countries every 4 years and in 2010 just before stopping • Middle-income countries gradually switch to IPV between 2006 and 2008 • High-income countries switch to IPV by 2005
OPV cessation with universal IPV	<ul style="list-style-type: none"> • Low-income countries gradually switch to IPV between 2008 and 2010 • Low-income countries use OPV pulse periodically before the switch to IPV • Middle-income countries gradually switch to IPV between 2006 and 2008 • High-income countries switch to IPV by 2005

Table 2. Parameters used in the analysis

	Cost per dose (US\$)			Routine immunization coverage rate (%)	
	OPV ^a	OPV NIDs ^b	IPV ^c	2005–10	2011–20
Low-income country	0.109	0.310	2.10	65	80
Middle-income country	0.144	— ^d	5.17	85	85
High-income country	— ^d	— ^d	10.96	95	95
Rate of VAPP ^e cases	3 per million birth cohort				

^a OPV = oral poliovirus vaccine.

^b NIDs = national immunization days.

^c IPV = inactivated poliovirus vaccine.

^d Costs were not applicable to the assumed scenarios and were not estimated.

^e VAPP = vaccine-associated paralytic poliomyelitis.

We used the current WHO method to estimate the expected number of VAPP cases. Adverse events related to injection safety issues (e.g. reuse of needles, disposal of needles) when introducing IPV depend on whether the vaccine will be introduced as a single antigen or in a combination vaccine with other antigens already being delivered. The potential global burden of adverse events (e.g. abscesses, transmittal of bloodborne pathogens) is not well documented, nor are these occurrences specific to polio immunization. Other adverse events due to IPV are exceedingly rare. Therefore, the costs of adverse events related to IPV were not included in this analysis.

Global cost of outbreak response capacity

Estimates of outbreak response capacity were limited to the costs of maintaining laboratory and epidemiological surveillance activities and the cost of creating and maintaining a stockpile of vaccines. The cost of outbreak responses or the costs of illness were not included because the probability and magnitude of an outbreak are unknown. Maintenance of a responsive surveillance and laboratory infrastructure was assumed under all policy scenarios during the time-frame presented. Global cost estimates were based on reported annual costs of laboratory and epidemiological surveillance (10). We have assumed that OPV will be the vaccine of choice in the stockpile. A vaccine stockpile was assumed for policies in which the use of OPV ceases and production is

assumed to decline. The initial size of the stockpile was assumed to be 500 million doses (2).

Analytical time frame

The analytical time frame is from 2005 to 2020. Assuming that new policies will be implemented over a 5-year period, the initial 5 years will not be an accurate picture of the average cost over the longer term. An additional 10 years are presented to allow a sufficient number of birth cohorts from which projections on immunization coverage and costs can be estimated. All estimates are presented in 2002 US\$ and future costs are discounted at a rate of 3%.

Results

Vaccine cost

Of the three policies, the global cost of *universal IPV* is the most costly, at US\$ 24 143 million (Table 3). This result is driven primarily by the high cost of IPV relative to OPV. *OPV cessation with optional IPV*, at US\$ 20 412 million, is the least costly policy but the cost difference between this and *continue OPV*, which has a cost of US\$ 21 089 million, is relatively small. There are two reasons for this. First, high-income and middle-income countries are assumed to switch to IPV, regardless of any global recommendation. Second, low-income countries are the

Table 3. Estimated costs of potential immunization policies, number of VAPP cases, and vaccine coverage, post-polio certification, 2005–20

	Continue OPV ^a	OPV cessation with optional IPV ^b	Universal IPV
Immunization costs (millions US\$)^c			
Low-income countries	1364	487	4418
Middle-income countries	12 196	12 196	12 196
High-income countries	6409	6409	6409
Total	19 969	19 092	23 023
Global response capacity	1120	1320	1120
Total global cost	21 089	20 412	24 143
Number of VAPP^d cases			
	3646	1278	1053
Coverage by 2020 for children <5 years old			
	89%	29%	89%

^a OPV = oral poliovirus vaccine.

^b IPV = inactivated poliovirus vaccine.

^c VAPP = vaccine-associated paralytic poliomyelitis.

only ones to experience a difference in immunization costs between these policies. The costs for low-income countries are 7% and 3% of the global costs for *OPV cessation with optional IPV* and *continue OPV*, respectively. Fig. 1 illustrates the costs for the different policies during 2005–20. Under *OPV cessation with optional IPV*, low-income countries experience a spike in costs before cessation because of the implementation of NIDs that precede cessation. Under *continue OPV*, costs increase over time because of increasing population size. Middle-income countries also experience a rapid increase in costs because of the switch to IPV. Costs increase more rapidly with *universal IPV*.

The low-income group is the only group assumed to be impacted by global post-certification polio immunization policy recommendations over time, and therefore the only one for which substantial differences in costs exist among the different policy options. Fig. 2 shows the cumulative immunization costs of the three policy options for low-income countries. Note that although the difference between the total costs of *continue OPV* or *OPV cessation with optional IPV* for low-income countries appears small, the difference represents half of the total cost of continued vaccination in low-income countries. A sensitivity analysis was conducted on the IPV price for low-income countries. By reducing the per-dose cost of IPV from US\$ 2.00 to US\$ 0.50, the total costs of using IPV in low-income countries over the period 2005–20 will be nearly equivalent to continuing OPV use with periodic supplemental immunizations during this same period.

This is the break-even point for low-income countries as a group. The break-even point for individual countries may vary depending on the actual costs of vaccine delivery.

A sensitivity analysis was also conducted on the total immunization costs of the middle-income countries. It was assumed that middle-income countries gradually switch to IPV, regardless of any global policy recommendation. If this assumption was removed and instead the policies of middle-income countries were similar to those of low-income countries, the global immunization costs for *continue OPV* and *OPV cessation with optional IPV* would be reduced by over 50%, from US\$ 19 969 million to US\$ 8277 million for *continue OPV* and from US\$ 19 092 million to US\$ 17070 million for *OPV cessation with optional IPV*.

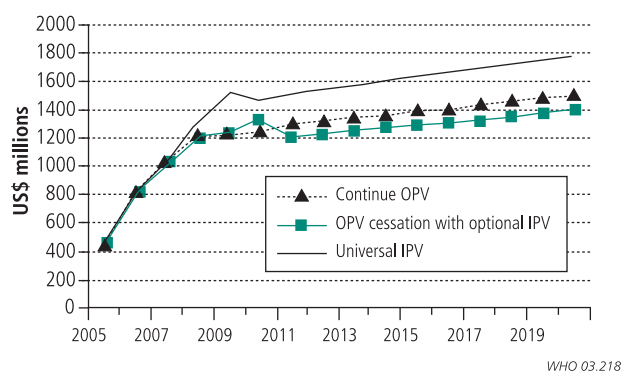
VAPP cases

The estimated total number of VAPP cases during 2005–20 is 3646, 1278 and 1053 for *continue OPV*, *OPV cessation with optional IPV*, and *universal IPV*, respectively. There are still some VAPP cases under *universal IPV* because we have assumed a gradual switch from OPV to IPV.

Global cost of outbreak response capacity

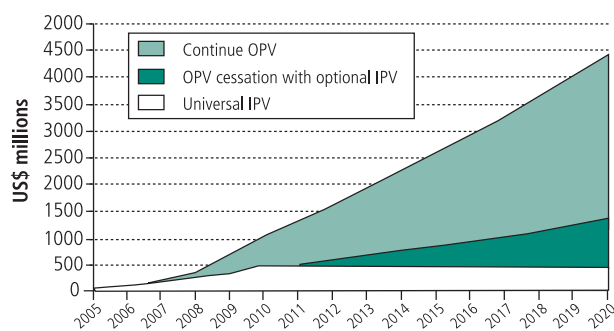
The outbreak response capacity cost for each of the policy options includes the cost of detecting an outbreak (both laboratory and epidemiological surveillance costs). The outbreak response capacity cost for *OPV cessation with optional IPV* and *universal IPV* also

Fig. 1. Annual global immunization costs



WHO 03.218

Fig. 2. Cumulative immunization costs: Low-income countries



WHO 03.219

includes the creation and maintenance of a vaccine stockpile. Although countries contribute their own resources to epidemiological surveillance and a laboratory network, these are difficult to estimate and are not presented. Only global costs based on current external funding requirements are presented.

It is probable that OPV rather than IPV will be the vaccine of choice during an outbreak (15, 16), but whether monovalent or trivalent OPV or a combination will be used is being debated. Here, we were conservative, and assumed that there would be enough vaccine stockpiled to distribute monovalent OPV of each serotype. The three types of OPV can be blended to make trivalent OPV. The assumption is that 500 million doses of trivalent OPV are needed for the initial stockpile; however, to ensure there is sufficient vaccine of each serotype, the number of monovalent OPV doses needed triples to 1.5 billion (500 million of each). The cost per dose of monovalent OPV is assumed to be the same as the current price per dose of trivalent OPV — US\$ 0.10, therefore the total cost of developing a stockpile would be US\$ 150 million. The total operational cost from 2005 to 2020 for developing and maintaining a stockpile is assumed to be US\$ 50 million. Laboratory and epidemiological surveillance costs are estimated at US\$ 70 million annually for a total of US\$ 1120 million during 2005–20 (10). *OPV cessation with optional IPV* and *with universal IPV* have a total cost of US\$ 1320 million. Lastly, the cost of outbreak response capacity, which includes maintaining laboratory and epidemiological surveillance, under *continue OPV* is US\$ 1120 million.

Discussion

This analysis presents some of the costs that will affect post-certification immunization policy decisions. The least costly policy option would be *OPV cessation with optional IPV*. *Universal IPV* has the highest costs, but when the price of IPV was reduced to US\$ 0.50 per dose, the total policy costs were the same as *continue OPV*. Some countries may begin to explore the option of combination vaccines — for example, IPV with other antigens — thus removing the cost of providing an additional injection. This break-even price of US\$ 0.50 in our results can also be interpreted as the incremental cost for including IPV in a combination vaccine that gives the same costs as *continue OPV*.

Projections on the cost of the vaccine are greatly dependent on supply and the ability to negotiate a competitive price. Estimates of the global vaccine costs were largely driven by the assumption that middle-income countries would gradually switch to IPV under any scenario. With the large population of the middle-income countries, which includes China, and the higher cost of IPV, middle-income countries contribute a great deal to the difference in the global cost of the different policy scenarios. If the price of IPV was to decrease over time or if fewer middle-income countries were to switch to IPV, the costs of *universal IPV* would be less.

Vaccine costs are not the only factor that will be taken into consideration in policy decision-making. The risk of VAPP continues to exist for those policies where there is OPV use, and *continue OPV* results in the highest number of VAPP cases.

Universal IPV results in fewer cases of VAPP during 2005–20 than *OPV cessation with optional IPV* because of NIDs conducted under the latter scenario before cessation. The number of VAPP cases for OPV cessation with optional IPV is 1278, compared with 3646 under the *continue OPV* policy option. Policy-makers should take into consideration not only the costs of the global policies, but also potential benefits such as avoiding VAPP cases. The costs of maintaining outbreak response capacity represent about 10% of the total programme cost. However, an increase in the price of OPV would increase the cost of maintaining a stockpile and responding to an outbreak.

Our analysis did not consider all costs. For example, we did not estimate the shared costs of providing routine immunization, and considered only the labour cost of providing the immunization and vaccine supplies. We underestimate the relative cost of *continue OPV* and *universal IPV* compared with *OPV cessation with optional IPV*, because for the latter these shared costs (overhead, transport, cold chain) would then be freed up in low-income countries to provide other health care services. Neither did we estimate the cost of increasing routine coverage rates. We did not estimate the expected cost of an outbreak; doing so would entail the generation of values for the risks of polio re-emergence. However, one would anticipate that such costs of responding to an outbreak would include a mass immunization response, increase surveillance and case investigation, training of responders, and replenishing the stockpile. It is the management of these risks and the expected costs and benefits that will ultimately drive the policy decisions.

The value of this analysis is to show policy-makers the relative global costs associated with various post-polio certification immunization policies. The major cost drivers are the price of the vaccine, the coverage rates, and the assumptions regarding the decisions of the individual country. Limitations of this analysis include the lack of information on additional country level costs (e.g. laboratory and epidemiological surveillance activities) and the lack of information on any costs incurred during an outbreak. Although initial cost estimates are helpful to policy-makers in understanding the relative costs of the different policy options, they are still only one factor the policy-maker will use to assess the costs and benefits of each policy. Additional research, such as an analysis on the risk factors associated with cVDPV, analysis to develop outbreak risk estimates, and estimating the size of an outbreak in the event of re-emergence of poliovirus after certification, is needed to examine the potential impact of each policy in terms of minimizing the risk of re-emergence of poliovirus circulation. ■

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Conflicts of interest: none declared.

Résumé

Analyse du coût des politiques vaccinales après la certification de l'éradication de la poliomyélite

Objectif Les auteurs ont procédé à une analyse pour estimer les coûts de différentes politiques vaccinales – actuellement à l'étude – pouvant être mises en œuvre après la certification, dans le but d'en informer les responsables de l'élaboration des politiques.

Méthodes Ils ont analysé trois politiques mondiales possibles : *poursuite de la vaccination par le vaccin antipoliomyélique buccal (VPO)* ; *arrêt du VPO avec possibilité de vacciner par le vaccin à poliovirus inactivé (VPI)* ; *arrêt du VPO, administration universelle du VPI*. Des hypothèses ont été formulées à propos des futures décisions prises par les pays à revenus faible, intermédiaire et élevé en matière de politiques vaccinales. Les auteurs ont estimé le coût de chacune d'entre elles, le nombre de cas post-vaccinaux et le coût mondial du maintien des moyens de riposte aux flambées épidémiques. Le coût financier de chaque politique vaccinale a été calculé sur la base des estimations du coût des vaccins, de leur administration et de la couverture projetée. Les auteurs ont inclus dans les coûts concernant le maintien des moyens de riposte aux flambées épidémiques les coûts inhérents à la constitution et à l'entretien de réserves de vaccins ainsi qu'à la surveillance des laboratoires et des épidémies. Ils ont analysé la période allant de 2005 à 2020.

Résultats *L'arrêt du VPO avec possibilité de vacciner par le VPI*

est, avec un coût estimé à US \$20 412 millions, l'option la moins coûteuse. Le coût mondial des moyens de riposte aux flambées a été estimé à US \$ 320 millions pour 2005–2020. L'option de *la poursuite de la vaccination par le VPO* entraîne le plus grand nombre de cas de poliomyélite paralytique post-vaccinale. *L'arrêt du VPO avec l'administration universelle du VPI* génère les dépenses les plus élevées mais aussi le nombre le plus faible de cas de poliomyélite paralytique post-vaccinale. Les analyses de sensibilité mettent en évidence que le coût mondial dépend du coût du vaccin retenu pour les hypothèses. Elles montrent aussi que, si le prix de la dose de VPI n'était plus que de US \$0,50 pour les pays à faible revenu, l'option *VPI universel* aurait le même coût que *la poursuite du VPO*.

Conclusion Le coût mondial de la vaccination après la certification dépend largement du coût unitaire des vaccins et des taux de couverture qui sont projetés. A US \$0,50 la dose de VPI, le passage au VPI ne coûte pas plus cher que la poursuite du VPO. Néanmoins, ces calculs ne tiennent pas compte des coûts générés par les cas de poliomyélite paralytique post-vaccinale résultant de la poursuite du VPO. En dehors du coût financier, l'évaluation des risques liés à la résurgence de la poliomyélite pèsera lourdement sur les décisions de politique.

Resumen

Análisis del costo de distintas políticas de inmunización tras la certificación de la erradicación de la poliomiélitis

Objetivo Se llevó a cabo un análisis para estimar los costos de diferentes políticas de inmunización poscertificación actualmente sometidas a estudio, con objeto de proporcionar dicha información a los formuladores de políticas.

Métodos Analizamos tres posibles políticas mundiales: *uso continuado de la vacuna oral contra el poliovirus (OPV)*; *interrupción de la OPV y uso opcional de la vacuna antipoliavirus inactivada (IPV)*; e *interrupción de la OPV más IPV universal*. Se asumieron ciertas premisas sobre las futuras decisiones de política en materia de inmunización por parte de los países de ingresos bajos, medios y altos. Estimamos el costo financiero de cada política de inmunización, el número de casos asociados a la vacuna (PAV) y el costo mundial del mantenimiento de la capacidad de respuesta a los brotes. El costo financiero de cada política de inmunización se calculó a partir de las estimaciones del costo de la vacuna antipoliomiélica, de su administración y de las proyecciones de cobertura. Los costos de mantenimiento de la capacidad de respuesta a los brotes comprenden los asociados al desarrollo y mantenimiento de una reserva de vacuna, además de la vigilancia de laboratorio y epidemiológica. Se analizó el periodo 2005-2020.

Resultados *La interrupción de la OPV con IPV opcional*, a un costo estimado de US\$ 20 412 millones, fue la opción menos

onerosa. El costo mundial de la capacidad de respuesta a los brotes se estimó en US\$ 1320 millones durante 2005-2020. La alternativa de *uso continuado de OPV* fue la que más casos de PAV produjo. La *interrupción de la OPV con IPV universal* fue la opción de mayor costo financiero, pero también la que conllevó el menor número de casos de PAV. Los análisis de sensibilidad mostraron que los costos mundiales eran sensibles a las premisas establecidas sobre el costo de la vacuna. El análisis también demostró que si el precio por dosis de IPV se redujera a US\$ 0,50 para los países de ingresos bajos, el costo de la *IPV universal* sería el mismo que el del *uso continuado de OPV*.

Conclusión Las proyecciones sobre el precio de la vacuna por dosis y las futuras tasas de cobertura fueron los principales determinantes de los costos mundiales de la inmunización antipoliomiélica poscertificación. El precio de equilibrio de la sustitución por la IPV en comparación con el mantenimiento de la inmunización con OPV es de US\$ 0,50 por dosis de IPV. Sin embargo, esa cifra no tiene en cuenta el costo de los casos de poliomiélitis de origen vacunal resultantes del uso continuado de OPV. Además de los costos financieros, las evaluaciones de riesgos relacionadas con la reaparición de la poliomiélitis serán determinantes muy importantes de las decisiones de política.

ملخص

تحليل تكاليف سياسات التمنيع في مرحلة ما بعد الإسهاد على استئصال شلل الأطفال

الغرض: أُجري تحليل لتقدير تكاليف مختلف سياسات التمنيع ضد شلل الأطفال، المطروحة حالياً للدراسة، والتي يُحتمل تطبيقها في مرحلة ما بعد الإسهاد على استئصال المرض، وذلك بغرض تقديم هذه المعلومات لراسمي السياسات. الطريقة: تم تحليل ثلاث سياسات عالمية مقترحة بغرض اختيار أنسبها. الأولى: استمرار إعطاء اللقاح الفموي لشلل الأطفال؛ والثانية: وقف إعطاء اللقاح الفموي لشلل الأطفال؛ والثالثة: وقف إعطاء اللقاح الفموي لشلل الأطفال مع إمكانية إعطاء اللقاح المعطل لشلل الأطفال؛ والنتيجة: وقف إعطاء اللقاح الفموي لشلل الأطفال مع تعميم إعطاء اللقاح المعطل لشلل الأطفال على مستوى العالم. وطُرحت عدة افتراضات حول القرارات المستقبلية لسياسات التمنيع التي يمكن أن تتخذها البلدان المنخفضة الدخل والمتوسطة الدخل والمرتفعة الدخل. وتم تقدير التكاليف المالية لكل سياسة من سياسات التمنيع المقترحة، وعدد حالات شلل الأطفال التي قد تحدث نتيجة للتعميم باللقاح، والتكاليف العالمية للمحافظة على القدرة على الاستجابة للفاشية. وتم حساب التكاليف المالية لكل سياسة تمنيع بناء على التكاليف التقديرية للقاح شلل الأطفال، وتكاليف إعطائه، وتقديرات التغطية بالتمنيع. وتتكوّن تكاليف المحافظة على القدرة على الاستجابة للفاشية من تكاليف إنتاج مخزون من اللقاح والاحتفاظ به، وتكلفة الترسّد المختبري والإبيدميولوجي (الوبائي). وتم تحديد الفترة من عام ٢٠٠٥ إلى عام ٢٠٢٠ كإطار زمني للتحليل.

الموجودات: قُدّرت تكلفة سياسة "وقف إعطاء اللقاح الفموي لشلل الأطفال مع إمكانية إعطاء اللقاح المعطل لشلل الأطفال" بنحو ٢٠٤١٢ مليون دولار، وهي أقلّ الاختيارات تكلفه. كما قُدّرت تكلفة المحافظة على القدرة على

الغرض: كانت التقديرات المتعلقة بثمن جرعة اللقاح ومعدلات التغطية المستقبلية بالتمنيع هي المحدّات الرئيسية للتكاليف العالمية للتمنيع في مرحلة ما بعد الإسهاد على استئصال المرض. أما النقطة التي يمكن عندها التحوّل إلى سياسة إعطاء اللقاح المعطل بدلاً من استمرار التمنيع باللقاح الفموي فهي عندما يصل ثمن الجرعة من اللقاح المعطل إلى نحو نصف دولار، وهي نقطة تعادل الثمن مع التكلفة. غير أن هذا لا يفسّر تكلفه حالات الإصابة بفيروس شلل الأطفال المشتق من اللقاح نتيجة استمرار إعطاء اللقاح الفموي. وبالإضافة إلى التكاليف المالية يُعدّ تقدير مخاطر إعادة ظهور المرض من المحدّات الرئيسية لقرار اختيار السياسة المناسبة.

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