Vaccines to prevent pneumonia and improve child survival

Shabir A Madhi,[a] Orin S Levine,[b] Rana Hajjeh,[b] Osman D Mansoor[c] & Thomas Cherian[d]

Abstract For more than 30 years, vaccines have played an important part in pneumonia prevention. Recent advances have created opportunities for further improving child survival through prevention of childhood pneumonia by vaccination. Maximizing routine immunization with pertussis and measles vaccines, coupled with provision of a second opportunity for measles immunization, has rapidly reduced childhood deaths in low-income countries especially in sub-Saharan Africa.

Vaccines against the two leading bacterial causes of child pneumonia deaths, *Haemophilus influenzae* type b (Hib) and *Streptococcus pneumoniae* (pneumococcus), can further improve child survival by preventing about 1 075 000 child deaths per year. Both Hib and pneumococcal conjugate vaccines have proven safety and effectiveness for prevention of radiologically confirmed pneumonia in children, including in low-income and industrializing countries. Both are recommended by WHO for inclusion in national programmes, and, at sharply tiered prices, these vaccines generally meet international criteria of cost-effectiveness for low-income countries. Vaccines only target selected pneumonia pathogens and are less than 100% effective, so they must be complemented by curative care and other preventative strategies.

As part of a comprehensive child survival package, the particular advantages of vaccines include the ability to reach a high proportion of all children, including those who are difficult to reach with curative health services, and the ability to rapidly scale up coverage with new vaccines. In this review, we discuss advances made in optimizing the use of established vaccines and the potential issues related to newer bacterial conjugate vaccines in reducing childhood pneumonia morbidity and mortality.

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Introduction

Pneumonia is the commonest cause of childhood mortality, particularly in countries with the highest child mortality, and it has been identified as the major "forgotten killer of children" by the United Nations Children's Fund (UNICEF) and WHO.[1] Almost all (99.9%) child pneumonia deaths occur in developing and least developed countries, with most occurring in sub-Saharan Africa (1 022 000 cases per annum) and South Asia (702 000 cases per annum). Of all pneumonia deaths, 47.7% occur in the least developed countries,[1] most of which are eligible to get support for the purchase of vaccines and development of their immunization programmes through the GAVI Alliance.[2]

Although various pathogens may cause pneumonia, either singly or in combination, the available evidence, including the effectiveness of case management, suggests that two bacteria are the leading causes: *Haemophilus influenzae* type b (Hib) and *Streptococcus pneumoniae* (pneumococcus).[3] WHO estimates that in 2000, Hib and pneumococcus together accounted for more than 50% of pneumonia deaths among children aged 1 month to 5 years.[4] Several effective vaccines are available for the prevention of childhood pneumonia, including two vaccines provided in immunization programmes in all countries, *Bordetella pertussis* and measles vaccines, and two relatively new vaccines, Hib conjugate vaccine (HibCV) and pneumococcal conjugate vaccines (PCVs).

In this paper, we aim to contextualize the potential role for vaccines as part of a package of childhood interventions, aimed at reducing childhood pneumonia morbidity and mortality. We summarize progress in the reduction of childhood pneumonia mortality with measles and pertussis vaccines; review the effectiveness of newer bacterial conjugate vaccines against pneumonia; and discuss the potential hurdles and likely solutions to ensure that pneumonia vaccines reach the populations at the greatest risk of pneumonia mortality.

Search strategy and selection criteria

We identified publications on the role of bacterial conjugate vaccines against pneumonia by searches of PubMed. Search terms included "pneumococcal conjugate vaccine", "Hib conjugate vaccine", "radiological pneumonia", "bacterial conjugate vaccine", "radiograph", "pneumonia", "child", "diagnosis" and "vaccine". Articles were selected on the basis of their relevance to pneumonia assessment in children. The summary of the role of measles and pertussis vaccines against pneumonia was sourced through the identification of key papers.

[a] Department of Science and Technology/National Research Foundation: Vaccine Preventable Diseases, University of the Witwatersrand, Chris Hani Baragwanth Hospital, Bertsham 2013, South Africa.

[b] Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, United States of America.

[c] Health Section, United Nations Children's Fund (UNICEF), New York, NY, USA.

[d] Department of Immunization, Vaccines and Biologicals, World Health Organization, Geneva, Switzerland.

Correspondence to Shabir A Madhi (e-mail: madhis@hivsa.com).

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Control of pertussis and measles

The last few decades have seen remarkable progress in reduction of mortality caused by pertussis and measles. Effective inactivated whole-cell pertussis vaccines have been available since the 1950s and are included in most immunization programmes worldwide. As a consequence, WHO estimates that in 2003, 38.3 million cases and 607 000 deaths were prevented by the use of pertussis vaccination.[5] However, pertussis is still estimated to cause 295 000–390 000 childhood deaths annually, with most deaths in countries with low immunization rates and high mortality rates.[6] Further gains can be made by increasing coverage with three doses of diphtheria-tetanus-pertussis vaccine in infancy and the provision of booster doses as appropriate.

The progress in reducing measles mortality has been even greater. Pneumonia as a complication following measles infection occurs in 2–27% of children in community-based studies and in 16–77% of hospitalized children.[7] Additionally, pneumonia contributes to 56–86% of all deaths attributed to measles.[7] The pathogenesis may be due to the virus itself or to superimposed viral or bacterial infections occurring in 47–55% of cases.[7] Pneumococcus is the most commonly identified organism (30–50% of all microbiologically confirmed tests).[8,9] In 1980, before the widespread use of measles vaccination in developing countries, there were more than 2.5 million deaths due to measles. This declined to about 873 000 deaths in 1999.[10] In 2001, a measles mortality reduction strategy was begun in 47 priority countries with the highest disease burden. This strategy consisted of increasing coverage with the first routine dose of measles vaccine, provision of a second opportunity, through supplementary immunization activities, appropriate case management and improved surveillance. The widespread implementation of this strategy, especially in priority countries in Africa, led to a further 60% reduction in the estimated measles deaths from 873 000 in 1999 to 345 000 in 2005.[11] A more ambitious global goal of 90% mortality reduction, compared with that in the year 2000, has been set for 2010.

HibCV and PCV effectiveness

Since 1996, the effectiveness of HibCV and PCVs for the prevention of childhood pneumonia has been established through eight clinical trials and three case–control studies, and is backed by numerous surveillance assessments (Fig. 1).[12–22]

HibCV

The first studies to show the effectiveness of HibCV for prevention of pneumonia were the randomized controlled trials from Chile and the Gambia.[12,13] Both studies showed significant protection against bacteraemic Hib pneumonia (80–100%) and radiologically confirmed pneumonia (about 22%). These studies also showed that the incidence of culture-negative pneumonia cases prevented was 5 to 10 times greater than the incidence of culture-confirmed cases prevented, supporting the observations that most bacterial pneumonia goes undetected by routine diagnostic methods and that vaccine trials are the most robust approach to the estimation of the burden of bacterial pneumonia.

More recently, additional clinical trials and case–control studies with HibCV have extended our knowledge to other geographic regions. A randomized controlled trial from Lombok in Indonesia helped to uncover the burden of Hib disease in Asia.[14] However, this study showed a significant reduction in the risk of clinical pneumonia but no reduction in the risk of radiologically confirmed pneumonia among vaccinated compared with unvaccinated children. Rates of clinical meningitis preventable by the vaccine were similar to rates observed in Africa and other high-risk areas. Consistent with the other studies, the burden of pneumonia prevented was about 10 times greater than the burden of meningitis prevented.

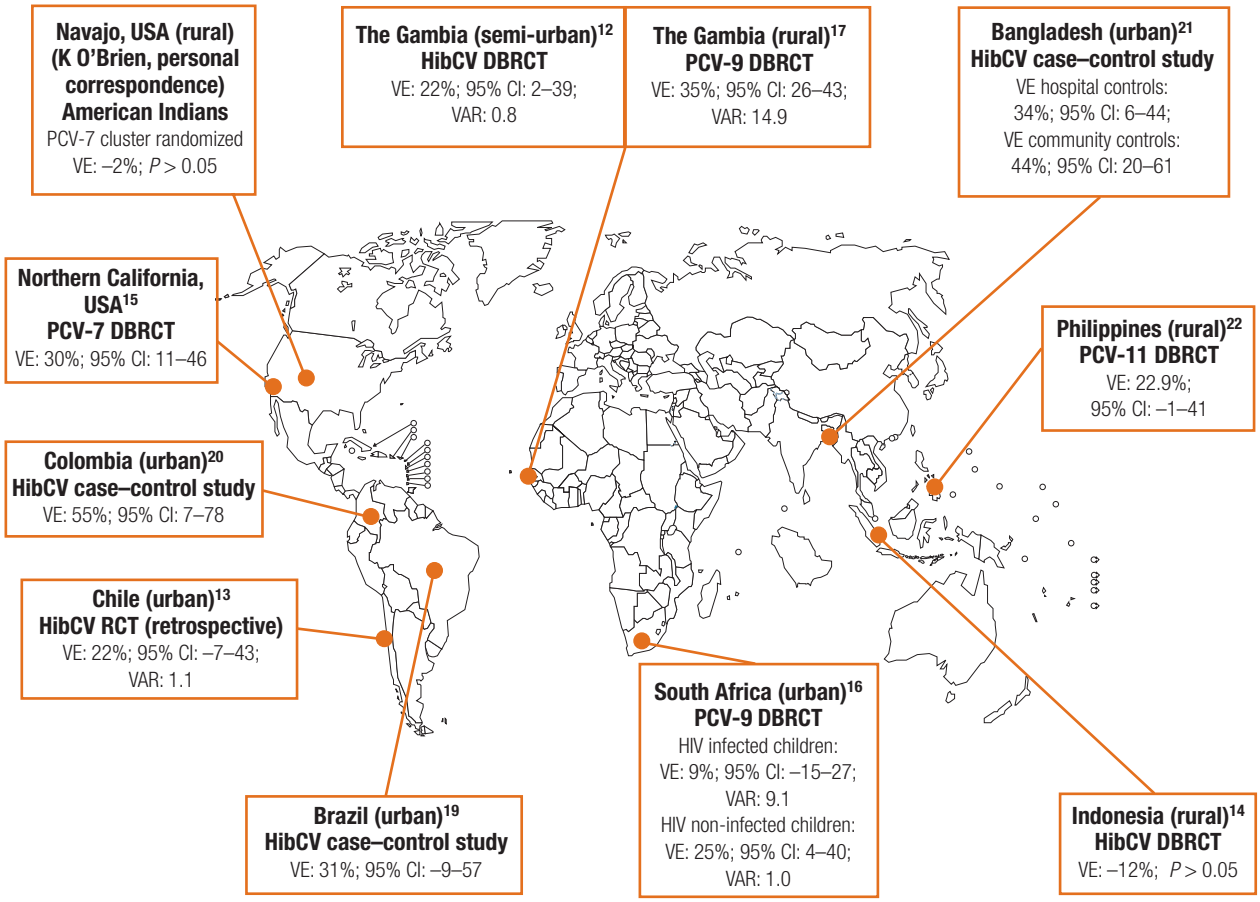
Case–control studies provide additional evidence of the effectiveness of HibCV for prevention of pneumonia.[19–21] A recent case–control study from Bangladesh showed that Hib vaccination was associated with a 34–44% reduction in the risk of radiologically confirmed pneumonia.[21] In this study, HibCV was distributed by use of a quasi-randomized approach and adjustments were made for key confounders. Estimates of high effectiveness of vaccines against radiologically confirmed pneumonia have also been reported from case–control studies from Brazil (31%) and Colombia (47–55%).[19,20]

All of the studies that evaluated the effectiveness of HibCV against pneumonia used a primary series of three doses of vaccine during infancy, albeit with different starting age and intervals between doses, and without an additional booster dose of vaccine provided during the second year of life. Only some of the later studies used a standardized approach for the interpretation of chest radiographs, which makes it difficult to compare studies.

PCVs

PCVs provide another effective method for pneumonia prevention in children and their families. Data are currently available from five randomized controlled trials of PCVs for prevention of pneumonia in children.[15–18,22] The comparison of studies is facilitated by the fact that each study used a standard interpretation of chest radiographs.[23] All children in each study received HibCV so the proportionate reductions in radiologically confirmed pneumonia were in addition to prevention due to HibCV. The two studies in the United States of America (USA) used seven-valent vaccine, and the two in Africa used a nine-valent vaccine and an 11-valent formulation was used in the Philippines. The studies represent a diverse range of epidemiological settings including rural Africa with a high infant mortality rate, urban Africa with a high HIV prevalence, periurban Asia with a high rate of antibiotic use, a Native American and a typical American health-maintenance-organization population. These studies found reductions (20–37%) of radiologically confirmed pneumonia that confirmed the importance of the pneumococcal vaccine serotypes as a cause of pneumonia.[15–17,22] Like HibCV, the large fraction of preventable disease is undetected by routine diagnostic methods. The efficacy of PCVs against vaccine-serotype bacteraemic pneumonia is high (67–87%),[15,16] but comparisons to the incidence of X-ray confirmed pneumonia or clinical pneumonia show that up to 20 times more culture-negative cases are prevented compared with culture positive cases.[24]

Fig. 1. **Global distribution of PCV and HibCV studies against radiologically confirmed pneumonia[a,b]**



CI, confidence interval; DBRCT, double-blind randomized controlled trial; HibCV, *Haemophilus influenzae* type b conjugate vaccine; PCV, pneumococcal conjugate vaccine; USA, United States of America; VAR, vaccine attributable reduction per 1000 child years of observation; VE, vaccine efficacy based against radiologically confirmed pneumonia by use of per-protocol analysis when available.

[a] All the studies evaluating PCV, as well as the HibCV studies in Indonesia and Bangladesh, used the WHO recommendations for interpreting and reporting on chest radiographs.[23]

[b] The study from Colombia used an algorithm score which included radiologically confirmed pneumonia as one of the criteria.

The use of a case-definition that is not specific for vaccine serotype disease (e.g. radiologically confirmed pneumonia, which can also be due to non-vaccine serotype pneumococci or other pathogens) will provide a more accurate estimate of the number of cases prevented, but may underestimate the proportionate reduction in vaccine-type pneumococcal pneumonia.[25] Radiologically confirmed pneumonia, although consistently used as an outcome measure to assess PCV efficacy, may nevertheless vary in its sensitivity (76.5% in the Gambia versus 58.1% in South Africa) across diverse settings.[17,24] In the USA, 3 years after PCV introduction, a 39% (95% confidence interval, CI: 22–52) reduction in pneumonia hospitalizations among children less than 2 years old was observed.[26] The absolute rate reduction for clinical pneumonia was 30 times greater than the reduction in pneumococcal pneumonia (506 versus 17 episodes prevented per 100 000 child-years) as per physician discharge diagnosis, again highlighting the difficulties in the diagnosis of pneumococcal pneumonia, even in industrialized countries, and the substantial effect of vaccination that can be missed by culture-based diagnoses. The higher than expected decline in clinical pneumonia in the USA, after the introduction of PCV, may have been due to PCV preventing the complication of a superimposed pneumococcal infection in children who had been infected by respiratory viruses. Such superimposed pneumococcal disease in children with respiratory viral infections was prevalent in almost a third of children hospitalized with severe pneumonia in the prevaccine era.[27]

The important role of pneumococcus in children with viral pneumonia was demonstrated in the South African vaccine efficacy trial, in which children vaccinated with nine-valent PCV were 31% (95% CI: 15–43) less likely to be hospitalized for pneumonia in which a respiratory virus was identified, including 45% (95% CI: 14–64) less likely to be hospitalized with pneumonia associated with influenza type A/B viruses.[28] Vaccination of children with PCV may play an important part in reducing the severity of respiratory viral associated pneumonia morbidity as well as in preparedness for a future influenza pandemic, because pneumococcal pneumonia commonly follows influenza illness.[29] Unlike Hib disease, which affects mainly children less than 2 years of age, pneumococcal disease also occurs among older children and adults. As a consequence, PCV immunization of children may confer protection to unvaccinated populations through herd protection.[30,31]

In the USA, this indirect effect of vaccination has prevented two to three times as many cases of invasive pneumococcal disease as through the direct effect of vaccinating young children.[32] The indirect effect is probably the cause of the 26% (95% CI: 4–43) reduction in pneumonia hospitalizations among those aged 18–39 years, 3 years after introduction of seven-valent PCV in the USA.[26]

Surveillance for culture-proven invasive disease is valuable because it provides the only opportunity to monitor the effectiveness of vaccine against specific serotypes and to detect changes in the distribution of serotypes causing disease. In the USA, the experience with non-vaccine serotype disease has varied across populations from the general population where, after 6 years, increases in non-vaccine-type disease are observed, but remain small in relation to the decline in vaccine-type disease compared with indigenous populations in rural Alaska, which have high rates of non-vaccine-type disease 3–5 years after vaccine use.[32,33] Serotype replacement in nasopharyngeal colonization and otitis media has been observed previously.[34] The most robust evidence of the value of PCVs for improving child survival comes from a trial in the Gambia in which nine-valent PCV reduced all-cause mortality by 16% (95% CI: 3–28) in vaccine recipients – an absolute reduction of 7.4 deaths prevented per 1000 vaccinated children.[17]

On the basis of disease burden and the proven effectiveness of HibCV and PCV in diverse settings, WHO recommends the inclusion of both of these vaccines in routine immunization programmes.[22,35] Together, HibCV and PCV, if applied everywhere, are expected to prevent at least 1 075 000 child deaths each year predominantly in developing countries, and with herd protection additional cases and deaths in older age groups.[4]

Influenza vaccines

Recent advances in the development of intranasal cold-adapted live-attenuated influenza vaccines hold potential for the reduction of childhood influenza.[36] The effect of influenza vaccine has been controversial, with one meta-analysis suggesting relatively low effectiveness and limited data for children less than 2 years of age.[37] A more recent analysis has suggested that methodological problems with some studies have led to underestimates of influenza vaccine efficacy in children.[38] Nevertheless, as with subunit influenza vaccines, which may prevent 87% of influenza associated pneumonia hospitalizations,[39] effective vaccination against influenza is dependent on the match between the strains included in the vaccine and circulating strains during any epidemic. The inclusion of influenza vaccination as a current strategy for the reduction of childhood pneumonia in many developing countries is complicated by the need to mobilize children for vaccination seasonally, logistical issues of cold-chain storage of the live-attenuated vaccines, concerns regarding its reactogenicity in very young infants, and the need for revaccination each year.

HIV infection and vaccination

Although children with HIV comprise less than 5% of the childhood population, even in heavily-burdened sub-Saharan African countries, these children suffer disproportionately from pneumonia (nine times greater risk) and are susceptible to pneumonia caused by a greater variety of pathogens.[24,40] In South Africa, HIV-infected children account for 45% of all childhood pneumonia morbidity and 90% of pneumonia mortality.[24,41] This high disease risk and broader array of causes complicates diagnosis and treatment and increases the importance of prevention. Data on HibCV and PCV in children infected with HIV show no safety concerns. The immune responses to HibCV and PCV are, however, reduced quantitatively and qualitatively attenuated. Antibody titres are maintained for a shorter duration, and memory responses are impaired compared with HIV non-infected children.[42–45] Suboptimum immune responses (25–75%) have also been observed against measles vaccine in children with HIV not on antiretroviral drugs.[46] For vaccinations in general, reviews of the safety, immunogenicity and effectiveness data of childhood vaccines in HIV-infected children have recently shown that the response to vaccines is strongly affected by the use of antiretroviral drugs.[46] For example, immune responses to PCV in children with HIV on antiretroviral therapy are similar to those in children not infected by HIV.[47]

PCV and HibCV are less effective against invasive disease in children with HIV not treated with antiretroviral drugs (65% and 54%, respectively), compared with children without HIV (83% and 90%, respectively).[16,48] Nevertheless, because of a 20–40 times increased risk of illness from these bacteria, HIV-infected children still derive a significant protective effect and the absolute burden of invasive disease and pneumonia prevented by the vaccines exceeds that of HIV non-infected children.[16,48] Within this context WHO has recommended that countries with a high prevalence of HIV prioritize the introduction of PCV into their immunization programmes.[21]

Future vaccines

Although currently available vaccines can prevent most pneumonia deaths in children, additional research is needed to define the cause of the remaining cases of pneumonia and to develop vaccines against these pathogens. The next agent preventable by vaccination may be non-typeable *H. influenzae*. A new pneumococcal conjugate vaccine that uses *H. influenzae* protein-D as a conjugate protects against acute otitis media caused by *H. influenzae*,[49] and is currently being assessed for effectiveness against pneumococcal and *H. influenzae* pneumonia. Non-typeable *H. influenzae* is a pneumonia pathogen in Asia.[50]

Other pathogens for which vaccines are currently being developed include respiratory syncytial virus,[51] which is the most common viral pathogen (25–35%) identified in children with pneumonia and bronchiolitis,[52,53] and parainfluenza virus type 3.[54] Additionally, improved vaccines to protect against pulmonary tuberculosis may also contribute to the control of the perpetual epidemic of childhood pneumonia. *Mycobacterium tuberculosis* causes pneumonia in about 8% of HIV-infected and HIV non-infected children hospitalized with severe pneumonia in sub-Saharan African countries.[55,56]

Cost-effectiveness

Childhood vaccination is widely regarded as one of the most cost-effective disease prevention interventions.[57] Numerous studies show that routine vaccination in developing countries

with HibCV, PCV, pertussis vaccine and measles vaccine meet the criteria for highly cost-effective health interventions over a range of plausible assumptions related to efficacy, price and disease burden. A recent review of intervention packages by Laxminarayan et al.[57] shows that programmes of childhood immunization and control of pneumonia mortality in children are highly cost-effective. The review shows a moderate cost-effectiveness of Hib containing vaccines. Laxminarayan et al. did not report a cost-effectiveness for PCV, but a recent cost-effectiveness analysis of pneumococcal vaccination in countries covered by the GAVI Alliance estimated that, at a price of US$ 5 per dose, a pneumococcal vaccine programme would meet or exceed the WHO threshold for "very cost-effective" in 69 of the 72 eligible countries.[58] These findings were conservative in the sense that they did not assume any herd protection among unvaccinated children or adults and did not assume any direct protection beyond the age of 2.5 years, although current evidence would suggest that both of these benefits are likely. Previous cost-effectiveness studies of HibCV and PCVs for developing countries had similar results.[59]

Advantages

Newer vaccines to prevent pneumonia can be delivered through existing immunization programmes, which in 2006 provided a third dose of diphtheria-tetanus-pertussis vaccine to about 79% of the world's birth cohort (WHO/IVB database). While vaccines only cover a few specific pathogens and only selected serotypes of some of the pathogens targeted, immunization has several other advantages that make it a highly effective tool for disease control. Immunization confers durable, long-lasting protection, it requires only a few contacts to confer that protection, is rapidly scalable and capable of reaching populations who are hard to reach through curative health services. Experience with introduction of hepatitis B vaccine and HibCV has shown that coverage with these vaccines can rapidly be increased to the same levels as a third dose of diphtheria-tetanus-pertussis vaccine. Even when these vaccines were not delivered in combination with diphtheria-tetanus-pertussis vaccines and where the introduction was phased within the country, coverage rates close to those of a third dose of diphtheria-tetanus-pertussis vaccine were achieved in most countries in 3 to 5 years. In countries where combination vaccines were introduced nationwide, coverage rates immediately increased to those of a third dose of diphtheria-tetanus-pertussis vaccine.

Thus, vaccines can rapidly reach a high proportion of the population and quickly lower disease rates. For some diseases, herd protection can extend the benefit of childhood vaccination to other age groups as well, an advantage that few other interventions can match. For both HibCV and PCV, the use of regimens with three doses given in infancy is effective, and current programmes in much of Africa and elsewhere do not include routine delivery of immunizations in the second year of life (i.e. "booster" immunizations), although close monitoring of disease is required to determine the need for additional doses in these settings.

Financing options

For many years, relatively high prices and limited, short-term purchasing finance obstructed the use of new vaccines in many developing countries. With the creation of the GAVI Alliance in 2000, financing for the poorest countries to access vaccines improved greatly. The alliance started by providing countries with up to 5 years of guaranteed financing for vaccine procurement and strengthening of immunization systems. Financing included support for expansion of vaccines to pertussis and measles, and for the purchase of HibCV. In 2005, the GAVI Alliance had its funding extended for 10 years, and in recent years has seen its total commitments increase from about US$ 750 million to over US$ 6 billion. This increase in funding includes more than US$ 500 million for strengthening health systems and US$ 1.5 billion for the purchase of PCVs through an innovative mechanism known as the Advance Market Commitment. To build national ownership and encourage evidence-based decisions, the GAVI Alliance requires a small co-payment (currently between US$ 0.15 and US$ 0.30 per dose) from countries for new vaccines such as HibCV and PCV. Early experience with HibCV and hepatitis B vaccines showed that overcoming the financial obstacles was necessary, but not sufficient, to accelerate introduction. The lack of evidence and policies to support decision-making in countries was also a major obstacle. In response, the GAVI Alliance also provided solutions by creating the Pneumococcal Vaccines Accelerated Development and Introduction Project and the Hib Initiative. These dedicated teams provide support for surveillance, research, cost-effectiveness analyses and other activities to encourage better decisions by GAVI Alliance partners, international agencies and national governments. The progress in assuring access for low-income countries through the GAVI Alliance has not been matched by progress in lower-middle-income countries. Some large countries with income levels just above the limit for GAVI Alliance-eligibility, such as Egypt and the Philippines, have many children living in poverty but lack the national financing to access new vaccines on their own. Without additional efforts to assure access for these countries, it will be difficult to avoid a situation of bimodal access to new vaccines, in which the richest and poorest countries have access but those in the middle are left to lag years behind.

The road ahead

Existing and new pneumonia vaccines are an important part of any package for the control of pneumonia in childhood. Indeed, each of the vaccines reviewed here is recommended by WHO for inclusion in national programmes. With new, sustained financing available to many developing countries, a major obstacle to the use of new vaccines has been largely overcome and the expanded use of all pneumonia vaccines is largely within reach of low-income countries. Although the road ahead is smoother than before, a great deal remains to be done. Success will require political will to make pneumonia prevention a priority, strengthening of health systems to assure that vaccines reach all children and continued research

to stay ahead of the bacteria and viruses that are already vaccine preventable and to develop new technologies for preventing those without vaccines. Expanded surveillance that allows countries to monitor the effect of vaccines and to adapt their programmes to respond to changes is also needed. ■

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Résumé

Vaccins destinés à prévenir la pneumonie et à améliorer la survie des enfants

Depuis plus de 30 ans, les vaccins jouent un rôle important dans la prévention de la pneumonie. Des progrès récents ont généré des opportunités d'améliorer encore la survie des enfants à travers la prévention par la vaccination des pneumonies infantiles. La délivrance au plus grand nombre possible des vaccinations anticoquelucheuse et antirougeoleuse systématiques, associée à l'offre d'une seconde opportunité de vaccination contre la rougeole, ont permis de réduire rapidement la mortalité chez l'enfant dans les pays à faible revenu, et notamment en Afrique subsaharienne.

Les vaccins contre les deux principales causes de mortalité infantile par pneumonie, à savoir les bactéries *Haemophilus influenzae* type b (Hib) et *Streptococcus pneumoniae* (pneumocoque), peuvent permettre d'accroître encore la survie des enfants, en prévenant environ 1 075 000 décès infantiles par an. Les vaccins anti-Hib et antipneumococcique conjugués ont tous deux fait la preuve de leur innocuité et de leur efficacité dans la prévention des pneumonies radiologiquement confirmées chez l'enfant, et notamment dans les pays à faible revenu et en cours d'industrialisation. L'OMS recommande d'introduire dans les programmes nationaux de vaccination ces deux vaccins qui, moyennant une forte modulation de leur prix, remplissent généralement les critères internationaux de rapport coût/efficacité pour les pays à faible revenu. Toutefois, ils visent sélectivement certains pathogènes à l'origine de pneumonies et ne sont pas efficaces à 100 %, de sorte qu'ils doivent être complétés par des soins curatifs et par d'autres stratégies de prévention.

Dans le cadre d'un ensemble complet d'interventions pour la survie de l'enfant, ces vaccins offrent l'avantage de pouvoir atteindre une forte proportion des enfants, y compris ceux difficiles à toucher par les services de santé curatifs, et de permettre un élargissement rapide de la couverture des nouveaux vaccins. Dans cette étude, nous examinons les progrès réalisés vers un usage optimal des vaccins établis et les problèmes que pourrait soulever l'utilisation de vaccins antibactériens conjugués plus récents pour réduire la morbidité et la mortalité par pneumonie chez l'enfant.

Resumen

Vacunas para prevenir la neumonía y mejorar la supervivencia infantil

Durante más de 30 años las vacunas han sido un arma fundamental para la prevención de la neumonía. Algunos progresos recientes han brindado nuevas oportunidades para seguir mejorando la supervivencia infantil previniendo la neumonía en la niñez mediante vacunación. La optimización de la inmunización sistemática con las vacunas antitosferinosa y antisarampionosa, unida a la implementación de una segunda oportunidad para la inmunización contra el sarampión, ha reducido rápidamente la mortalidad en la niñez en los países de ingresos bajos, sobre todo del África subsahariana.

Las vacunas contra las dos causas bacterianas principales de muerte por neumonía en la infancia, *Haemophilus influenzae* tipo b (Hib) y *Streptococcus pneumoniae* (neumocócico), pueden mejorar aún más la supervivencia infantil previniendo alrededor de 1 075 000 defunciones infantiles cada año. Las vacunas conjugadas contra Hib y contra el neumococo han demostrado su seguridad y eficacia en la prevención de la neumonía confirmada radiológicamente en los niños, tanto en los países de bajos ingresos como en los nuevos países industrializados. La OMS recomienda la inclusión de ambas en los programas nacionales, y a precios fuertemente escalonados estas vacunas satisfacen en general los criterios internacionales de costoeficacia para los países de ingresos bajos. Las vacunas actúan sólo contra algunos de los agentes patógenos causantes de neumonía y su eficacia es inferior al 100%, de modo que requieren como complemento atención curativa y otras estrategias de prevención.

Componente de un paquete integral de supervivencia infantil, las vacunas presentan como ventajas particulares la posibilidad de dar alcance a un alto porcentaje de niños, incluidos aquellos a los que los servicios de salud curativos sólo consiguen llegar con grandes dificultades, y la posibilidad de expandir rápidamente la cobertura con vacunas nuevas. En este análisis consideramos los avances logrados para optimizar el uso de las vacunas establecidas y las cuestiones que pueden plantear las nuevas vacunas antibacterianas conjugadas en lo tocante a reducir la morbilidad y la mortalidad infantiles por neumonía.

ملخص

لقاحات للوقاية من الالتهاب الرئوي وتحسين معدلات بقاء الأطفال

منذ أكثر من ثلاثين عاماً واللقاحات تلعب دوراً مهماً في مجال الوقاية من الالتهاب الرئوي. وقد أتاحت أوجه التقدُّم الذي حدث مؤخراً الفرص لتحقيق مزيد من التحسُّن في معدلات بقاء الأطفال، عن طريق توقِّي الإصابة بالالتهاب الرئوي الطفولي من خلال التطعيم. وقد أسفر الوصول بالتمنيع الروتيني بلقاحَيْ السعال الديكي والحصبة إلى أقصى حد، مع توفير فرصة ثانية للتطعيم ضد الحصبة، عن تحقيق خفض سريع في وفيات الأطفال في البلدان المنخفضة الدخل، ولاسيَّما في أفريقيا جنوب الصحراء.

ويمكن للقاحات المضادة لأكبر سببَيْن جرثوميَيْن لوفيات الأطفال

الناجمة عن الالتهاب الرئوي، وهما المستدمية النـزفية، النمط ب، والعقدية الرئوية، أن تحقق مزيداً من التحسن في معدلات بقاء الأطفال، بالحيلولة دون وقوع 1075 000 من وفيات الأطفال كل عام. ولقد ثبتت مأمونية ونجاعة اللقاح المزدوج للمستدمية النـزفية النمط ب، والعقدية الرئوية، في توقِّي الإصابة بالالتهاب الرئوي المؤكَّد شعاعياً لدى الأطفال، في كل من البلدان المنخفضة الدخل والبلدان الصناعية. وتوصي منظمة الصحة العالمية بإدراج هذين اللقاحَيْن في البرامج الوطنية، كما أن هذين اللقاحَيْن، في ظل الارتفاع الحاد في أسعار اللقاحات، يستوفيان، بصفة عامة، المعايـير الدولية في ما يتعلَّق بالفعالية لقاء التكاليف وذلك بالنسبة للبلدان المنخفضة الدخل. فاللقاحات تستهدف فقط مسبـبات مرضية بعينها للالتهاب الرئوي، كما أنها لا تـتصف بالفعالية التامة بنسبة 100%، الأمر الذي يستلزم تكملتها بالرعاية العلاجية وغيرها من الاستـراتيجيات الوقائية.

وكجزء من حزمة شاملة لبقاء الأطفال، فإن المميزات المحددة للقاحات تـتضمَّن قدرتها على الوصول إلى نسبة عالية من جميع الأطفال، بمن فيهم أولئك الذين يصعب إيصال خدمات الرعاية العلاجية إليهم، والقدرة على الارتقاء السريع بالتغطية باللقاحات الجديدة. وفي هذه الدراسة، ناقش الباحثون أوجه التقدُّم المحرز في تحقيق الاستخدام الأمثل للقاحات المعتمدة، والقضايا الممكنة المتعلقة بدور اللقاحات الجرثومية المزدوجة الجديدة في تقليص مراضة ووفيات الأطفال الناجمة عن الإصابة بالالتهاب الرئوي.

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