

# Integrating pneumonia prevention and treatment interventions with immunization services in resource-poor countries

Adam L Cohen,<sup>a</sup> Terri B Hyde,<sup>b</sup> Jennifer Verani<sup>a</sup> & Margaret Watkins<sup>b</sup>

**Abstract** Pneumonia is a leading cause of morbidity and mortality worldwide. Effective vaccine and non-vaccine interventions to prevent and control pneumonia are urgently needed to reduce the global burden of the disease. This paper explores practical strategies and policies for integrating interventions to prevent and treat pneumonia with routine immunization services, and it investigates the challenges involved in such integration. The primary pneumonia prevention and treatment strategies that are implemented during routine childhood immunization visits are vaccination of children against the disease, caretaker education and referral of children to medical services when necessary.

Abstracts in **عربي, 中文, Français, Русский and Español** at the end of each article.

## Introduction

Pneumonia – a lung infection caused by bacteria, viruses and, more rarely, fungi – is the most common cause of death in children worldwide. Every year an estimated 156 million new cases of pneumonia and nearly 2 million deaths from the disease occur in children under 5 years of age.<sup>1,2</sup> In an effort to reduce pneumonia mortality and morbidity, the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) recently developed a framework of interventions known as the Global Action Plan for the Prevention and Control of Pneumonia (GAPP). This action plan aims to prevent children from getting pneumonia (e.g. through vaccination) and to provide those who get pneumonia with appropriate case management.<sup>3</sup> A growing body of literature describes research that integrates routine immunization services with health interventions such as bednet distribution for malaria control, mebendazole treatment for intestinal parasitosis, vitamin A supplementation, household water treatment and family planning.<sup>4,5</sup> As health officials work to reduce the global burden of pneumonia, we are provided with an opportunity to learn from these integration efforts. This paper explores practical approaches for integrating diverse pneumonia prevention and treatment interventions with immunization services.

## Vaccine interventions

Vaccines are effective against some of the main causes of pneumonia, although they provide protection against only certain pathogens or specific pathogenic serotypes. Two vaccines against bacterial pathogens – *Streptococcus pneumoniae* (pneumococcus) and *Haemophilus influenzae* type b (Hib) – are currently available in many countries worldwide. The Hib vaccine, which has been proven effective against pneumonia in the field, currently reaches about half of all children born worldwide.<sup>6</sup> Pneumococcal vaccine is primarily used in higher-income countries; it has been used in only a few resource-poor countries, but evidence from efficacy trials suggests that it will be effective there too.<sup>7</sup> If given to all children worldwide, these two vaccines could prevent more than half of the world's cases of radiologically-confirmed pneumonia.<sup>8,9</sup> Unfortunately, these

vaccines can be prohibitively expensive for low- and middle-income countries.

Seasonal influenza is a major cause of pneumonia in children. Nevertheless, seasonal influenza vaccine is not widely used and has not been tested in the field for its effect on the burden of pneumonia.<sup>10</sup> All three vaccines – pneumococcal, Hib and seasonal influenza – are currently recommended by WHO to be administered to young children.<sup>11–13</sup> Other major causes of childhood respiratory disease (e.g. respiratory syncytial virus, adenovirus, parainfluenza virus, *Staphylococcus aureus* and non-typhoidal *Salmonella* spp.) cannot currently be prevented through vaccination.

Even if vaccines against pneumonia were introduced into routine childhood immunization programmes, reaching all children in a given country would require a strong, fully-functioning immunization system. Globally, most children who develop pneumonia reside in low-income countries, many of which have weak immunization systems.

## Non-vaccine interventions

Vaccinating children against pneumonia, which is feasible if pneumococcal and Hib vaccines are introduced into routine infant immunization systems, is vitally important. However, it is not a panacea. Integration of non-vaccine pneumonia interventions with the childhood immunization platform could potentially be more cost-effective, efficient and sustainable than multiple vertical programmes. For example, pneumonia case management has proven to be effective in a variety of settings,<sup>9,10</sup> although it is not always correctly practised. Other interventions that may be effective involve providing education to caregivers or giving them referrals to medical services during immunization visits. Some examples would be promoting breastfeeding and good nutrition, reducing exposure to indoor air pollution, testing for human immunodeficiency virus (HIV), or providing a product that can be used to reduce the risk of pneumonia (e.g. soap for hand washing or zinc supplements). These interventions have a much weaker evidence base than vaccination or case management. The few studies that have evaluated breastfeeding, hand washing, reduced indoor air pollution and zinc treatment for diarrhoea were well designed but need replication;<sup>14–18</sup> zinc treatment for pneumonia has shown mixed results.<sup>19</sup>

<sup>a</sup> National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA, 30333, United States of America (USA).

<sup>b</sup> Center for Global Health, Centers for Disease Control and Prevention, Atlanta, USA.

Correspondence to Adam L Cohen (e-mail: dlvj1@cdc.gov).

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## Opportunity to immunize

Childhood immunization is one of the most equitable and highly used child survival interventions given through direct patient care. For example, global coverage with the third dose of diphtheria–tetanus–pertussis (DTP3) vaccine is 82%, far more than the global coverage of referral of clinical pneumonia cases to health workers, which is only 54%.<sup>20</sup> Routine infant immunization and pneumonia prevention and treatment interventions often target the same population, since most routine immunizations are administered in the first year of life, when the risk of pneumonia is highest. Four or more immunization contacts in the first year of life provide an opportunity to educate caretakers and reinforce health messages and are one of the few ways to equitably and acceptably provide services to mothers and children several times a year. In addition, many countries use community-based services to promote immunization, organize outreach efforts and conduct tracking activities. Community-based workers could be used to improve health promotion for interventions designed to prevent pneumonia. The vaccination of pregnant women with tetanus toxoid is another potential avenue for targeting interventions.

## Challenges

The integration of health interventions and immunization services and its effects have not been well studied in the field; only limited data are available on the public health impact of such integration. Country health officials are already exploring ways to integrate pneumonia prevention and control strategies as part of the GAPP framework. However, to our knowledge, few if any published studies have addressed optimal ways to implement integration or have evaluated the effectiveness of linking pneumonia prevention and treatment interventions with immunization services.<sup>5</sup> Some pneumonia interventions may be difficult to deliver through routine immunization services. Using the GAPP framework, [Table 1](#) describes several potential pneumonia interventions (vaccine and non-vaccine) that could be integrated into immunization services, the strength of effectiveness of these interventions against pneumonia, and potential challenges for integration.

There are challenges to integrating pneumonia prevention and treatment interventions with immunization services, as noted in [Table 1](#). Adding more work to the immunization programme without provision of more staff, resources and time may strain a sometimes fragile programme.<sup>32</sup> As with other health interventions that are integrated into immunization services, the delivery strategy needs to fit the intervention. The delivery strategy could involve making the intervention part of an immunization campaign, periodically intensifying routine immunization activities or conducting routine immunization visits. Some interventions can be more feasibly implemented during facility-based routine immunization service delivery than through outreach activities. Unlike the distribution of insecticide-treated bednets or of vitamin A supplements during mass vaccination campaigns, many of the interventions in [Table 1](#) aimed at reducing pneumonia lack a physical product that can be distributed on a mass scale. Products such as cleaner-burning cooking stoves are heavy and bulky and difficult to distribute when mobile immunization outreach is conducted on a motorcycle. An intervention such as the purchase of new stoves may call for financial decisions from men, who seldom participate in the routine immunization of their children. In addition, a substantial proportion of childhood pneumonia deaths occur in the neonatal period and would be missed during most routine immunization visits. Preventing low birth weight, which is mentioned in GAPP, is not included in [Table 1](#) because there is no obvious way to integrate such prevention with vaccination.

Rigorous evaluation will be needed to assess both the feasibility and the impact of integrating pneumonia interventions with immunization programmes. To assess the feasibility of integrating the two, countries will need to assess how acceptable this is to the target population and to health-care workers and will have to ensure that integration does not adversely affect existing, robust programmes, such as immunization services. Evidence of the effectiveness of interventions to prevent pneumonia can convince stakeholders that integration is worth supporting; however, implementing multiple strategies concurrently may make it difficult to separate the effects of each intervention. As discussed in [Table 1](#), many of these interventions have

a relatively small impact on the overall burden of pneumonia. While reducing by 20% the incidence of a disease with a large global burden, such as pneumonia, is a worthy goal, measuring the impact of the intervention in the field often requires a large study population and rigorous study design. Instead of conducting large trials in multiple settings, it may be more appropriate to conduct demonstration projects with pneumonia endpoints in a limited number of settings and to evaluate pneumonia interventions elsewhere, through intermediate outcomes such as knowledge or behaviour change.

Collaboration and sharing of resources are both a strength and a challenge for integration activities. For example, a reduction in routine immunization coverage might be acceptable if there is a concomitant increase in other effective interventions. Administratively, within a country's ministry of health, different departments are often responsible for different interventions; thus, ownership by different stakeholders and lack of coordinated leadership could hinder integration. For example, immunization services typically reside within the Expanded Programme on Immunization (EPI), whereas interventions to reduce indoor air pollution through the use of cooking stoves may reside in the energy or environment ministry. Similarly, funding and human resources are limited and are separate for each intervention, and programmes may fear that integration will weaken or overburden their own delivery system. Hence, human resources for these interventions may need to be shared between different ministries. The GAVI Alliance provides co-financing for the introduction of pneumococcal and Hib vaccines in the world's poorest countries, but many other pneumonia prevention and treatment interventions do not have direct sources of funding outside a country's limited health budget. Planning for integration activities should therefore involve affected stakeholders from the outset.

Some interventions for pneumonia prevention and control under the GAPP, such as breastfeeding and hygiene promotion, can also dramatically reduce diarrhoeal diseases, the second most common cause of death in children less than 5 years of age worldwide. Diarrhoea has also been targeted by a global strategic integration initiative that includes interventions similar to those included in the GAPP.<sup>33</sup> Integration of

Table 1. Approaches to integrating pneumonia prevention and treatment interventions with immunization services, categorized by intervention<sup>3</sup>

Strategy	Intervention	Strength of effectiveness against pneumonia	Potential challenges
<b>Provide good nutrition and a healthy environment</b>			
Promote exclusive breastfeeding for 6 months	Implement breastfeeding programmes and educate parents during routine infant immunization visits	Up to 20% of postnatal pneumonia deaths are attributed to suboptimal breastfeeding, <sup>21</sup> but few studies have assessed the effectiveness of breastfeeding programmes on pneumonia; <sup>14,22</sup> promotion of exclusive breastfeeding is estimated to reduce pneumonia incidence by 15–23%. <sup>23</sup>	Difficult to change habits; more frequent contact may be needed to change behaviour; insufficient time during visit
Promote adequate nutrition	Assess nutritional status and educate parents during routine infant immunization visits	Pneumonia more common in malnourished children; adequate nutrition can reduce child deaths by 6% in children aged 6–23 months. <sup>24</sup>	May be difficult to measure impact of intervention on pneumonia; insufficient time during visit
Reduce exposure to indoor air pollution through use of improved cooking stoves	Educate parents during routine infant immunization visits and refer to vendors of stoves	Risk of pneumonia is 1.8 times higher in children exposed to unprocessed solid fuels; <sup>25</sup> improved stoves led to as much as a 75% reduction in pneumonia incidence in specific settings; <sup>23</sup> single trial of improved stoves reduced pneumonia. <sup>16</sup>	Infrastructure for distributing stoves necessary; stoves expensive and difficult to distribute; insufficient time during visit
Reduce exposure to indoor air pollution through smoking cessation	Educate parents during routine infant immunization visits	Effectiveness against reducing pneumonia in children not tested, but WHO states that environmental tobacco smoke is harmful to children. <sup>26</sup>	Difficult to change habits; more frequent contact may be needed to change behaviour; insufficient time during visit
Increase hand washing	Distribute soap; educate parents during routine infant immunization visits or during immunization campaign	Few studies in resource-poor settings, but one study found hand washing reduced pneumonia by 50% after intensive community intervention. <sup>15</sup>	Difficult to change habits; insufficient time during visit; provision of soap may not be enough (e.g. if water sources are limited)
<b>Prevent childhood pneumonia</b>			
Promote routine vaccination against infection with <i>Streptococcus pneumoniae</i> , Hib, and seasonal influenza	Include vaccine in routine childhood immunization programme	Pneumococcal and Hib conjugate vaccines reduced pneumonia by approximately 26% and 18%, respectively, in clinical trials when given as infant immunization; <sup>27,28</sup> limited data on effectiveness of pneumococcal conjugate vaccine in resource-poor countries; <sup>27</sup> influenza a significant cause of pneumonia in some countries, but vaccines are a less tested method of reducing childhood pneumonia. <sup>10</sup>	Vaccines are expensive, require cold-chain capacity and are not yet licensed in all countries; annual vaccines such as the vaccine against influenza are not easily integrated into routine immunization systems <sup>10</sup>
Promote catch-up vaccination against <i>Streptococcus pneumoniae</i>	Integrate catch-up pneumococcal vaccination campaign with measles campaign	No data on effectiveness when given as part of mass vaccination campaign	Difficult to time availability and introduction of pneumococcal vaccine with measles campaigns (supplemental immunization activities); may adversely affect measles coverage
Reduce incidence of HIV in children through HIV counselling and testing, and co-trimoxazole prophylaxis for HIV-infected and exposed infants	Educate parents and implement HIV testing of parents and children during routine infant immunization visits; refer to HIV care for co-trimoxazole prophylaxis	HIV testing at immunization visits is feasible in the field; <sup>29</sup> effectiveness against reducing pneumonia not tested, but could reduce childhood deaths by 2%. <sup>24</sup>	Need strong health systems for HIV care and treatment; insufficient time during visit as HIV counselling, testing and treatment takes more time than typical vaccination encounter; co-trimoxazole resistance in bacteria that commonly cause pneumonia

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Strategy	Intervention	Strength of effectiveness against pneumonia	Potential challenges
Promote zinc supplementation	Provide zinc supplements to all children or to ill children with concurrent diarrhoea during immunization visit	20% decline in pneumonia incidence with zinc supplementation; <sup>17</sup> 14–15% reduction in pneumonia incidence when zinc given as part of treatment for diarrhoea; <sup>23</sup> other nutritional supplements (e.g. vitamin A, iron) not clearly effective <sup>22</sup>	May be difficult to measure impact of intervention; zinc administration during pneumonia not a proven intervention
<b>Treat children with pneumonia</b>			
Increase case management of pneumonia in community, health centre and hospital	Teach caregivers to seek care from trained CHWs if child ill; CHWs could treat or refer ill children to medical care during vaccination campaign; provide pneumonia treatment kits	35% or larger decline in childhood pneumonia mortality and 20–27% decline in all mortality from community-based interventions <sup>19,20,21</sup>	Need policy to allow CHWs to provide antibiotics; need strong health systems; few cases are likely to be identified in the field during campaigns; CHWs may not be part of the formal health system
Teach parents to recognize signs and symptoms of pneumonia	Educate parents during routine infant immunization visits	Effectiveness against reducing pneumonia in children untested	Important to teach parents, but may not be effective in reducing incidence of pneumonia; important to explain to parents and health workers that current pneumonia vaccines do not prevent all types of pneumonia; insufficient time during visit

CHW, community health worker; Hib, *Haemophilus influenzae* type b; HIV, human immunodeficiency virus; WHO, World Health Organization.

routine immunization strategies with pneumonia prevention and control efforts could be combined with diarrhoeal control strategies – administration of rotavirus vaccine, home water treatment and use of oral rehydration solution – to achieve a greater impact on childhood mortality.

## Conclusion

Effective vaccine and non-vaccine interventions to prevent and control pneumonia are urgently needed to complement the global push to vaccinate children against pneumonia. The most important and straightforward approach to preventing pneumonia during routine immunization visits is to vaccinate children against pneumococcal and Hib infection. The next highest priority interventions we propose are educating caretakers about pneumonia and giving referrals to pneumonia prevention services at the time of the immunization visit. Pivotal evaluations of pneumonia interventions are needed to develop the evidence base for establishing pneumonia prevention tools beyond vaccines. Research is also needed to evaluate the feasibility of integration, its optimal practices and its effectiveness, as well as its possible unintended consequences. One approach will not fit all settings; thus, an individual country will need coordinated leadership to assess and develop frameworks that focus on high-impact, sustainable interventions that are feasible and of interest to that country.<sup>3</sup> National coordinating groups may provide appropriate country-level forums to address the implementation of integration activities across various departments and to leverage resources to achieve the common goal of reducing pneumonia and other vaccine-preventable diseases. Such groups, which may already exist or be new, could include national immunization technical advisory groups or interagency coordinating committees. Use of coordinating groups will make it easier to transform and integrate the EPI with other disease control programmes within countries. To determine the best approach to reducing deaths from pneumonia in children throughout the world, it will be necessary to implement and evaluate the impact of integrated strategies before programmes are rolled out on a large scale. ■

**Competing interests:** None declared.

## ملخص

دمج تدخلات توقي الالتهاب الرئوي وعلاجه مع خدمات التمنيع في البلدان فقيرة الموارد ينطوي عليها هذا الدمج. تتمثل الاستراتيجيات الرئيسية لتوقي الالتهاب الرئوي سبب رئيسي للمراضة والوفاة في جميع أنحاء العالم. وتوجد حاجة ملحة لتدخلات فعّالة عن طريق اللقاح وغيره للوقاية من الالتهاب الرئوي والسيطرة عليه بغية خفض العبء العالمي لهذا المرض. تستكشف هذه الورقة الاستراتيجيات والسياسات العملية لدمج التدخلات للوقاية من الالتهاب الرئوي وعلاجه مع خدمات التمنيع الروتيني، وتبحث التحديات التي

## 摘要

## 资源贫乏国家中通过免疫接种服务进行肺炎的综合防治

在全世界范围内，肺炎是发病及死亡的主要原因。因此急需采用有效的疫苗及非疫苗干预法防止并且控制肺炎以便减小全球范围内的疾病负担。该论文探索了综合干预法的实际战略及政策以便在普通的免疫服务机构防治肺炎。该

论文研究了此次综合干预法面临的挑战。儿童肺炎主要防治方案是注射疫苗防止疾病，对小孩看护人员进行教育，确保万一出现任何症状，及时送往医疗机构进行诊治。

## Résumé

## Intégration des interventions de prévention et de traitement de la pneumonie aux services de vaccination dans les pays pauvres

La pneumonie est une des principales causes de morbidité et de mortalité dans le monde. Il est urgent de mettre en place des campagnes de vaccination efficaces et des interventions sans vaccination pour prévenir et contrôler la pneumonie afin de réduire les effets de la maladie dans le monde. La présente analyse explore les stratégies pratiques et les politiques d'intégration des interventions permettant de prévenir et de traiter la pneumonie grâce à des services de vaccination systématiques.

Elle fait également le point sur les conséquences d'une telle intégration. Les stratégies de base de prévention et de traitement de la pneumonie mises en œuvre au cours des consultations de vaccination systématiques chez les enfants consistent à les vacciner contre la maladie, à éduquer ceux qui les prennent en charge et à renvoyer les enfants vers les services médicaux si nécessaire.

## Резюме

## Объединение мероприятий по профилактике и лечению пневмонии с вакцинацией в странах с ограниченными ресурсами

Пневмония является одной из основных причин заболеваемости и смертности во всем мире. Чтобы ослабить глобальное бремя этого заболевания, необходимо в кратчайшие сроки прибегнуть к вакцинации, а также предпринять другие эффективные меры по профилактике и борьбе с пневмонией. В данной статье рассматриваются практические стратегии и методы объединения мероприятий по профилактике и лечению пневмонии с плановой

вакцинацией, а также исследуются проблемы, возникающие в ходе такого объединения. Основными стратегиями профилактики и лечения пневмонии, применяемыми в ходе плановой вакцинации детей, являются их вакцинация против данного заболевания, обучение лиц, осуществляющих уход, и, при необходимости, направление детей в медицинские учреждения.

## Resumen

## Integración de las intervenciones de prevención y tratamiento de la neumonía en los servicios de inmunización en países con pocos recursos

La neumonía es una de las principales causas de morbilidad y mortalidad en todo el mundo. Es necesario poner en práctica de manera urgente intervenciones de vacunación y no vacunación eficaces para prevenir y controlar la neumonía, con el fin de reducir la carga global de la enfermedad. Este documento examina las estrategias y políticas prácticas para la integración de las intervenciones de prevención y tratamiento de la neumonía en los servicios de inmunización rutinaria,

e investiga los desafíos que conlleva una integración de este tipo. Las estrategias primarias de prevención y tratamiento de la neumonía que se llevan a cabo durante las visitas de inmunización infantil rutinarias son la vacunación de niños contra la enfermedad, la formación de los cuidadores y la derivación de los niños a los servicios médicos cuando se estima oportuno.

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