Global Action Plan for the Prevention and Control of Pneumonia (GAPP)

REPORT OF AN INFORMAL CONSULTATION

World Health Organization

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Technical consensus statement

The following consensus statement was agreed on, and should be used widely for advocacy purposes and to help promote the global action plan.

- Pneumonia kills more children than any other illness in the world. Pneumonia is a significant problem in communities with a high rate of under-five mortality, and places a huge burden on families and the health system. Pneumonia control is therefore a priority and is essential in achieving the fourth MDG.
- In the context of child survival strategies, countries should develop plans for controlling pneumonia. The key strategies for pneumonia control are:
  - case management with IMCI at all levels
  - vaccination
  - improvement of nutrition/low birth weight
  - control of indoor air pollution
  - prevention and management of HIV infection.
- Priority should be given to applying the strategies first in those countries with the highest current rates of child pneumonia and highest mortality.
- These interventions, if implemented, have the potential to reduce pneumonia mortality and morbidity by more than half.
- Effective case management at the community and health facility levels is an essential part of pneumonia control. Countries with significant rates of under-five mortality should adopt plans to expand adequate case management of pneumonia following IMCI at hospital, health facility and community levels to achieve 90% coverage within a predetermined time frame.
- All countries should take steps to achieve Global Immunization Vision and Strategy (GIVS) targets for measles and pertussis containing vaccines; countries that have not yet done so should add Hib and conjugate pneumococcal vaccines to their national immunization programmes, especially if they have high child mortality.
- Promotion of exclusive breastfeeding and appropriate complementary feeding are an important element of pneumonia prevention. Strategies to reduce rates of low birth weight and malnutrition will prevent pneumonia and should be encouraged.
- Indoor air pollution increases the risk of pneumonia. New technologies can reduce indoor air pollution, and additional research is needed to demonstrate the health benefits of these interventions. Strategies to reduce indoor air pollution may prevent pneumonia and should be encouraged.
- Strategies to prevent mother-to-child transmission of HIV and to improve the management of HIV infection and P. jiroveci (previously P. carinii) pneumonia prophylaxis in children should be promoted in countries where HIV is prevalent.
- Other preventive strategies, such as encouraging hand washing, should be promoted.
- Pneumonia is a common and serious consequence of pandemic influenza. Preparedness for pandemic influenza should include prevention and control of pneumonia and adds urgency to community case management.

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Background

The fourth Millennium Development Goal (MDG), which focuses on child survival, calls for a two thirds reduction in under-five mortality compared to the 1990 baseline. About 10 million children under five years of age die every year. The biggest killers are pneumonia, diarrhoea and neonatal causes. Pneumonia is also responsible for a significant proportion of deaths classified under "neonatal causes". It is estimated that, including neonates, pneumonia may cause up to 2.4 million deaths annually, mostly in the African, South-East Asian and Eastern Mediterranean regions of WHO. This represents 1.5–2 times more child deaths than those from malaria and HIV infection together in these same regions. In sub-Saharan Africa, HIV has resulted in a rapid increase in the incidence of pneumonia morbidity and mortality, and this has led to additional challenges regarding differences in epidemiology and the potential for vaccine strategies in reducing this burden. As of 2005, more than 150 million childhood pneumonia cases are estimated to occur every year in the developing areas of the world, with 73% occurring in just 15 countries. However, the incidence of child pneumonia has increased by 45% in South Africa alone since 1995, owing to the additional disease burden contributed by HIV, so that total global incidence today may be even higher.

Thus pneumonia remains one of the major challenges to child health and survival. This is despite the fact that a range of risk factors have now been identified, leading to the availability of preventive and curative measures of proven efficacy and effectiveness. A focused and integrated approach at country level to implement and scale up the use of interventions of known effectiveness, particularly in some high-burden countries, however, should lead to a dramatic reduction in child morbidity and mortality due to pneumonia. A recent report by UNICEF and WHO[1] highlights the importance of pneumonia and outlines strategies to reduce mortality through such an integrated approach. There is no "magic bullet" for all circumstances but a set of tools that can be applied as indicated by local circumstances that, in combination, can have a major impact. Some of the main tools are related to vaccines, mother and child nutrition, case management and the environment. Only by these means can the ambitious MDG for child health be achieved.

Over the past few years, new data have become available on the impact of a variety of interventions that have the potential to reduce the pneumonia burden. Needed now, however, is a comprehensive assessment of the new information on the potential impact of these interventions, the obstacles and opportunities for scaling up their use, and an integrated approach to delivering them to maximize their impact. The main approaches to pneumonia prevention are to reduce exposure to risk factors and provide protection through vaccination. Risk factors were reviewed in 2004, but an in-depth comparative assessment of risk factors for under-five mortality or pneumonia mortality has not yet been undertaken. Other new data are also becoming available. For example, a recent randomized controlled trial in Guatemala showed that reducing indoor air pollution by providing stoves with a chimney gave an impressive reduction in cases of severe pneumonia. Zinc has been shown to be efficacious in preventing pneumonia, with conflicting results on its role in the case management of pneumonia. Use of co-trimoxazole as prophylaxis in HIV-infected children resulted in a significant reduction in mortality in a study

[1] United Nations Children's Fund (UNICEF) and World Health Organization. *Pneumonia: the forgotten killer of children.* New York, UNICEF, 2006.

from Zambia. In HIV settings, introduction of highly active antiretroviral treatment (HAART) has also reduced morbidity and mortality from childhood pneumonia. Other preventive strategies that have shown promise are hand washing, breastfeeding and reducing overcrowding. More study of the influence of these risk factors is needed.

Whereas some progress has been made in understanding and addressing risk factors, the main progress to date in the prevention of pneumonia has been achieved through the development of new vaccines. "Older" vaccines against measles and pertussis have resulted in significant reductions in the burden of these diseases where high coverage rates are maintained. In addition, "newer" vaccines against *Haemophilus influenzae* type b (Hib) and *Streptococcus pneumoniae* (pneumococcus) have shown high protective efficacy against pneumonia in controlled trials as well as under routine circumstances in some countries. In the case of Hib, the impact of routine immunization on pneumonia is assumed based on the demonstrated impact against invasive disease following vaccine introduction and the impact on pneumonia seen in clinical trials. Direct measurement of the effect of routine Hib immunization on pneumonia is much more difficult to measure, although case–control studies following vaccine introduction have demonstrated a 20–40% efficacy against radiologically confirmed pneumonia. Several pneumococcal vaccine trials have been completed and have shown efficacy against radiologically confirmed pneumonia ranging from 20% to 37%. The Global Alliance for Vaccines and Immunization (GAVI) is providing support to eligible countries for the introduction of Hib vaccine, and from 2008 will support the introduction of pneumococcal conjugate vaccines in eligible countries.

Effective early management of pneumonia in resource-poor developing countries, through the development and continued improvement of a simple case management strategy, has for several years been a cornerstone in the reduction of pneumonia mortality. The mainstay of pneumonia case management is the provision of inexpensive antibiotics by peripheral health workers in the context of the Integrated Management of Childhood Illness (IMCI). There is continued interest in the management of pneumonia by community health workers, and WHO and UNICEF have recommended that community health workers can treat ambulatory (non-severe) pneumonia effectively with oral antibiotics. Some initiatives to promote this practice at community level have been undertaken. This approach is threatened by the potential emergence of common bacteria resistant to the first-line antibiotics and the need to use more expensive alternatives. However, the clinical relevance of *in vitro* antimicrobial resistance for pneumonia is still unclear. Furthermore, the specificity of the pneumonia diagnosis and over-treatment becomes another important issue, especially with the increasing use of vaccines that will prevent pneumonia caused by common bacterial pathogens. Although standard case management has rationalized the antibiotic use for pneumonia, there is a need to review the initial assessment and therapy failure criteria to further reduce antibiotic use. Case management is also quite challenging in many populations because of cultural, geographical, logistical and seasonal factors (aside from poverty), particularly where pneumonia can proceed from first signs to death within 48 hours. Studies have also shown that a shorter course of antibiotic therapy is equally effective in treating pneumonia. A trial in Pakistan revealed that severe pneumonia can be successfully treated with oral antibiotics, and more research is under way to explore it further. Children with severe pneumonia, both of viral and of bacterial origin, are often hypoxaemic, so WHO has been promoting the availability of oxygen in small hospitals in developing countries. Several surveys of these hospitals in recent years, however, have shown that oxygen is either not available at all in many hospitals or is not used appropriately for children. Hospital improvement initiatives aim at improving assessment of hypoxaemia through the use of a pulse oximeter, improving oxygen supply and its delivery to hypoxaemic children.

Etiological studies have helped in defining the spectrum of causative organisms, but there are still major gaps in knowledge on the proportion of pneumonia due to various etiologies and on specific issues such as bacterial–viral interaction. The last set of large-scale studies was undertaken in the 1980s with the support of the United States Board of Science and Technology for Interna-

tional Development (BOSTID). But a lack of sensitive tools for diagnosing bacterial pathogens causing pneumonia results in an underestimation of the true burden of bacterial pneumonia and a lack of awareness of health workers of the various bacterial pathogens and their proportional contribution to the pneumonia burden, since they seldom perform cultures and when they do the cultures are seldom positive. The availability of new diagnostic modalities to diagnose infectious pathogens provides the opportunity to develop better tools to define the etiology of pneumonia and apply them in epidemiological studies.

The lack of a coordinated effort on the prevention and control of pneumonia in developing countries constitutes one of the main obstacles for the achievement of the fourth MDG. The Fifth International Symposium on Pneumococci and Pneumococcal Diseases, held in Alice Springs, Australia in April 2006, issued a call for action on childhood pneumonia, the main cause of which is the complex interplay between poverty, poor household environment (overcrowding, poor hygiene and smoke), malnutrition and respiratory pathogens (*S. pneumoniae*, *H. influenzae* and viruses). The main cause of the high mortality from pneumonia (mainly in developing countries) is a lack of access to effective health services. The lack of political commitment and interest from donors also contributes to pneumonia not being adequately addressed.

A Global Action Plan for Pneumonia (GAPP) has been proposed in order to increase awareness of pneumonia as a major cause of child death, to call for the scaling up of the use of the interventions of proven benefit and to develop a plan to achieve this. The meeting at La Mainaz near Gex, the outcomes of which are reported here, is a first step in the development of the GAPP.

Objectives of the meeting

The objectives of the meeting were to:

- identify topics for review in developing technical consensus on interventions to be promoted and the strategies for accelerating their use in developing countries;
- develop the outlines for each review and identify groups to develop the reviews; and
- reach consensus on the process and timelines for the development of the GAPP.

Expected outcomes

The expected outcomes from the meeting were:

- a detailed outline of review areas and timelines for the working groups and suggested composition of the groups; and
- an outline and consensus for the GAPP and agreement on timelines.

Summary of the presentations and discussion

DAY 1 | 5 MARCH 2007

The meeting was opened by Dr Jose Martines, acting Director of the Department of Child and Adolescent Health and Development (CAH) at WHO, who emphasized the importance of pneumonia, its relative neglect over the years in terms of public health approaches, and WHO's willingness to address this issue. Dr Renée Van de Weerdt, representing UNICEF, expressed her Organization's support, as the co-sponsoring agency, for the meeting and for the concept of GAPP overall. Dr Kim Mulholland was elected Chair of the meeting. He drew attention in his opening remarks to the relative neglect of pneumonia control, and particularly the lack of progress towards reducing pneumonia mortality. He mentioned that, despite overall improvements in child survival, there were examples of countries where pneumonia mortality was not declining. Case management, the main WHO strategy for pneumonia control, was often not optimally implemented, especially at peripheral level, and communities often depended on hospitals as their source of treatment. The introduction of Hib and pneumococcal vaccines had had the potential to substantially reduce the pneumonia burden, but were not the only solution. They needed to be complemented by other measures, one reason why the current meeting had been convened. That general measures could be very successful was illustrated by the historical example of the United States, where pneumonia mortality declined considerably before the introduction of either vaccines or antibiotics.

The programme of the meeting and the list of participants are given in Annexes 1 and 2, respectively.

Epidemiology and etiology of pneumonia

Dr Harry Campbell presented the work undertaken by him and Dr Igor Rudan in the context of the Child Health Epidemiology Reference Group (CHERG) on the epidemiology and etiology of pneumonia (for details see http://www.who.int/child-adolescent-health/publications/pubCNH.htm#EPI).

Pneumonia incidence

The current best estimate for global incidence of clinical pneumonia in children under five years of age is a median of 0.29 episodes per child (0.21–0.71 interquartile range). This equates to approximately 151 million new episodes a year, of which 11–20 million episodes (7–13%) are severe enough to require hospital admission. However, this estimate is based on only 28 good quality studies; moreover these are limited in that individual studies reflect only their specific setting and are unlikely to be more widely representative, and that there were no studies from countries with HIV as a major public health problem. Regional and national estimates are available based on a model of risk factor prevalence and published risks estimates associated with these risk factors. A review of the available data for pneumonia has recently been published.

Accurate etiology-specific estimates of incidence are difficult to obtain in community-based studies that intervene with treatment early in the disease process, and owing to the lack of sensitivity

of methods and selection bias in hospital studies. The best estimates come from vaccine probe studies, which suggest that approximately 17 million episodes of pneumococcal pneumonia and 5.6 million episodes of Hib pneumonia occur worldwide each year.

Pneumonia mortality

The most recent pneumonia mortality estimates are based on verbal autopsy studies, which employ various definitions of pneumonia and various methods for assigning cause of deaths (primary and competing). It has been noted that the proportion of pneumonia deaths in these studies tends to diminish with more detailed verbal autopsy procedures, and it is particularly difficult to distinguish between pneumonia and malaria deaths and to assign the true cause of death in neonates. Historical pneumonia mortality estimates were published by Leowski in 1986 and Garenne in 1992. The most recent published estimate by Williams in 1992 of 1.9 million child deaths globally (95% CI: 1.6–2.2 million) excluded measles deaths. However, there are several problems with this estimate, including the fact that few studies were from high-mortality regions (leading to an unstable estimate), no studies were from countries with high HIV rates, many published mortality studies were not included, and insufficient attention was given on how to handle neonatal deaths. The Williams estimate was that pneumonia accounted for 19% of all deaths or about 1.9 million child deaths per year worldwide. This contrasts with the current CHERG estimate by Bryce in 2005 of 19% (aged one month to five years) plus 9% deaths from neonatal pneumonia and sepsis. The Williams estimate needs to be revised by attending to these limitations and incorporating additional studies identified by Morris in his review. It is important to note that pneumonia has been found to be an important associated cause of death, and thus the impact of pneumonia interventions will not be limited to pneumonia deaths.

A meta-analysis of randomized control trials of vaccine efficacy data suggests that annually about 700 000 deaths in young children are due to pneumococcal pneumonia and about 300 000 to Hib pneumonia.

Discussion

In the discussion, it was stressed that the vaccine probe studies provided an alternative way of measuring the burden of Hib and vaccine-type pneumococcal pneumonias. This method was not available for other etiologies, most notably for respiratory syncytial virus (RSV). There was an attempt in the context of CHERG to address the burden of RSV by collecting data from large studies that provided a community base to hospital studies, many of these coming from vaccine trials. Research was needed on why some children with pneumonia die and what lessons can be learned from the reduction in pneumonia mortality in the pre-antibiotic era.

Prevention through vaccination

Dr Shabir Madhi presented an overview of pneumonia prevention through vaccination. His talk was supplemented by two presentations: by Dr Rana Hajjeh on behalf of The Hib Initiative; and by Dr Orin Levine on the Pneumococcal vaccine Accelerated Development and Introduction Plan (PneumoADIP).

WHO recommends that routine immunization programmes in all countries include four vaccines that prevent pneumonia – measles, pertussis, Hib conjugate and pneumococcal conjugate. These vaccines have demonstrated efficacy in preventing pneumonia in diverse settings. Optimal prevention of pneumonia through vaccination can be achieved by expanding coverage with measles and pertussis vaccines, and accelerating and sustaining the introduction of Hib and pneumococcal conjugate vaccines. Strengthening health systems, building surveillance capacity, creating evidence-based demand, and assuring sustainable financing are fundamental to achiev-

ing the full impact of existing pneumonia vaccines. Additional research is also needed to improve existing vaccines and to develop vaccines against important infectious agents that are not yet vaccine-preventable, including respiratory syncytial virus.

Discussion

The discussion raised the issue of the uncertainty of Hib vaccine estimates in Asia. Questions as to how long immunity lasts after vaccinations and the available evidence on serotype replacement for pneumoccacl vaccine remained unresolved, particularly in developing countries. Thus, there will be need for high-quality surveillance to address the above-mentioned issues, especially in those countries that use Hib and pneumococcal vaccines earlier than others.

Nutrition

Dr Laura Caulfield made a presentation on "The role of nutrition in pneumonia disease burden: an update of the evidence on the global burden of disease (GBD)". The goal of the presentation was to update participants on the information gathered for a forthcoming series in *The Lancet* on undernutrition and GBD. This included a discussion of the role of overall malnutrition in childhood – characterized by low height for age (stunting), low weight for age (underweight) and low weight for height (severe acute malnutrition) – on the risk of pneumonia morbidity and mortality.

She related the earlier work carried out for the GBD report published in 2005 with changes in the characterization of undernutrition, using the new WHO growth standards (2006) and new analyses examining how underweight, stunting and wasting, defined using the new standard, confer risk of pneumonia mortality. WHO has also produced new estimates of underweight, stunting and wasting, to be used with these new risk estimates for recalculating GBD for morbidity and mortality, including that from pneumonia. Low birth weight at term also confers risk for pneumonia morbidity and mortality, and some new analyses were presented examining its role in respiratory infectious causes of neonatal mortality. Zinc deficiency is a known risk factor for pneumonia morbidity and mortality, with the evidence base derived from randomized controlled trials. Dr Caulfield presented some updated meta-analysis figures on the effects of zinc supplementation in the prevention of pneumonia. She touched on the role of certain prominent micronutrients (vitamin A, iron and iodine) in the risk of contracting pneumonia. In the case of vitamin A, there were a couple of reports suggesting that vitamin A supplementation caused a slight increase in the risk of pneumonia morbidity.

Suboptimal breastfeeding (defined as the infant not being exclusively breastfed during the first 6 months) and complete weaning before 24 months have recently been examined as risk factors for pneumonia morbidity and mortality. Dr Caulfield also presented some as yet unpublished findings that will be key inputs to the series in *The Lancet*.

Discussion

The discussion indicated the group's appreciation of the width of the field, and that nutritional factors played a role beyond the prevention of pneumonia. Nevertheless, it was considered useful to systematically review the effect on pneumonia. The effect of low birth weight, which would continue as low weight for age and might itself have an effect on pneumonia, needed further investigation. In addition, many HIV-infected children would present with malnutrition and pneumonia, both being manifestations of the underlying illness. A nutritional intervention would have little effect here, whereas antiretroviral therapy would improve the malnutrition.

Indoor air pollution

Dr Kirk Smith gave an overview of the effect of indoor air pollution on pneumonia morbidity and mortality. This was followed by a presentation by Dr Nigel Bruce on the findings of the Guatemala air pollution intervention trial.

Indoor air pollution from the burning of solid household fuels such as biomass and coal in simple stoves is an established risk factor for disease in women and young children. The best available evidence indicates that, compared to use of an open wood fire for cooking indoors, an efficient wood stove with a chimney can lower the risk of severe non-RSV pneumonia by about 40% and of all pneumonia diagnosed by a qualified physician by about 15% in children under 18 months of age. This result comes from a recent randomized controlled trial in Guatemala, in which detailed exposure assessment was also conducted. It is consistent, if somewhat smaller in effect, that the results of a meta-analysis of more than a dozen observational studies of household biomass fuel smoke exposures in Africa and Asia in children under five. It is also consistent with dozens of studies of the effects of environmental tobacco smoke and outdoor air pollution on children at lower exposure levels. Based on the evidence, an even greater reduction in pneumonia incidence could be expected from the introduction of clean household fuels or high-efficiency biomass stoves.

Discussion

Dr Maria Neira, Director of the Department of Public Health and the Environment at WHO, joined the meeting for this session and the discussion. She referred to the importance of environmental risk factors that contribute to and/or worsen pneumonia in children, mentioning the latest data provided in the WHO publication *Preventing disease through healthy environments*.[1] This states that, adding together the effects of indoor and outdoor air pollution and other indoor conditions, at least 42% of all lower respiratory infections can be attributed to the environment in developing countries, compared with 20% in developed countries. Co-morbidities that are partly attributable to the environment (e.g. malaria and diarrhoea) may add to the burden of lower respiratory infections. Dr Neira stressed the importance of addressing the preventable risk factors, such as the indoor burning of biomass fuels and second-hand tobacco smoke. She expressed the support of her department for this work, and said that while environmental interventions are often not seen as cost-effective taken in isolation, they need to be seen in the wider context of human health, in which they are then fully worth their cost. She appreciated the comprehensive approach to pneumonia control, which did not focus on one narrow aspect but took into consideration the environmental causes and triggers.

DAY 2 | 6 MARCH 2007

Dr Kim Mulholland opened the second day of the meeting with an overview of the main points from the presentations and discussion on the first day. There are issues with the implementation of available interventions. The large-scale introduction of standard case management at the community and health facility levels has been variable. GAVI has heavily subsidized the large-scale introduction of Hib vaccine in developing countries, and the introduction of pneumococcal vaccine will require a similar level of subsidy. There has been a broader application of nutrition interventions, including the promotion of breastfeeding and reduced incidence of low birth weight. There has been no large-scale intervention to reduce indoor air pollution, a measure that is perceived as very expensive.

[1] Prüss-Üstün A, Corvalán C. *Preventing disease through healthy environments. Towards an estimate of the environmental burden of disease*. Geneva, World Health Organization, 2006.

Case management: community-based treatment

Dr David Marsh presented his work on community-based treatment of pneumonia, providing examples of: (*a*) pneumonia case management (modified IMCI) at scale, (*b*) parameters of programme quality and (*c*) the main challenges faced.

The examples of scale were drawn from the literature (Bangladesh, Gambia, Honduras, Kenya, Nepal and Pakistan) and from the experience of the Basic Support for Institutionalizing Child Survival (BASICS) Project in Africa (Benin, Democratic Republic of the Congo, Ghana, Madagascar, Niger, Rwanda and Senegal) and Save the Children (United States) (Afghanistan, Bolivia, Ethiopia, Mali, Myanmar and Nicaragua). An updated, more complete survey is in preparation.

Quality parameters include inputs, processes and results. *Quality inputs* comprise: political will; programmatic platform; site selection criteria; engaged communities affirming local workers; evidence-based diagnostic flow charts; competency-based training; coherence among training, supervision, job aids and quality monitoring; respiratory rate timers; job aids and forms; and continuous supplies of genuine drugs. *Quality processes* include: continuous availability of curative care; patient follow-up protocols; health system links tailored to the setting; communities overseeing drug use and service quality; supportive supervision; and a companion behavioural change strategy to promote illness recognition and care-seeking as well as adherence to recommended treatment and occasional referral. *Quality results* involve: scale, use (counts or rates of actual/expected by disease) and quality of service; household knowledge and practices; and others such as client and community satisfaction, community capacity and informed policy.

The many challenges begin with the "central conundrum": those rural settings with high mortality rates that are most in need of the strategy tend to have the weakest health systems, so that optimal supply, supervision, support and referral options are compromised. Other challenges consist of policy barriers, especially regarding the placing of antibiotics (not to mention injectable ones) in the hands of community health workers; unintended consequences, such as identifying more morbidity; optimal training strategy; costs and cost recovery; drug resistance and re-supply; continuous service availability; patient adherence; and strategic relevance in settings of declining mortality and/or increased use of interventions to prevent pneumonia.

Discussion

It was mentioned that further review of the evidence was needed regarding the actual implementation of community-based intervention to manage pneumonia.

Case management: facility-based treatment

Dr Stephen Graham presented the current status of case management for pneumonia at facility level and its main challenges. Effective management of children with pneumonia is an important part of an overall strategy to reduce pneumonia-related deaths. The case management approach was formulated by WHO in the 1980s and was shown to be effective when implemented. The main foundations of this approach include: (*a*) appropriate use and choice of antibiotics against the major causes of bacterial pneumonia (pneumococcus and Hib), since it is assumed that bacterial pneumonia is the cause of the majority of pneumonia deaths; (*b*) training health workers to utilize simple clinical signs to assess severity and guide appropriate treatment; and (*c*) appropriate and effective use of oxygen. Both the severity of pneumonia and that of hypoxia correlate strongly with mortality.

Case-fatality rates for severe pneumonia remain high in settings poor in resources, especially in the African Region of WHO. Important challenges for improved case management include:

- the effective application of recommended case management;

- improved definition and management of clinical overlap (especially with malaria and conditions causing wheeze);
- improved definition and management of treatment failure;
- change in the spectrum of bacterial pathogens, especially in Hib-vaccinated populations; and
- the impact of paediatric HIV infection.

Improvement of case management in hospitals has recently shown that training health workers and providing antibiotics and oxygen can reduce pneumonia case-fatality rates by up to 30–40%. Pneumococcus remains the most important pathogen, but Gram-negative bacteria seem to be now relatively more common than Hib. For example, multidrug-resistant non-typhoidal *Salmonella* spp. are common isolates from children with pneumonia in tropical Africa. Pneumonia is the commonest cause of morbidity and mortality in HIV-infected children. Infections with opportunistic pathogens such as *Pneumocystis jiroveci* and cytomegalovirus are particularly common in HIV-infected infants and are associated with a high case-fatality rate. Recent evidence suggests that tuberculosis is a common cause of acute severe pneumonia in regions with an increasing burden of smear-positive pulmonary tuberculosis among young adults, especially in HIV-endemic regions.

There is still much that can be done to reduce pneumonia-related mortality, especially through the improvement of inpatient management of severe pneumonia. The priorities for effective management still remain appropriate antibiotics, oxygen availability and adequate numbers of trained health care workers. There are additional challenges in regions endemic for HIV/TB, where effective strategies such as preventing mother-to-child HIV transmission, co-trimoxazole preventive therapy for HIV-exposed and infected children, and management of children in close contact with cases of sputum-smear-positive tuberculosis need to be more widely applied.

Comparative risk assessment

Dr Majid Ezzati presented an overview of the methods and analytics of comparative risk assessment (CRA), including the effects of individual risk factors as well as those of multiple risk factors acting simultaneously. He described the data sources used in the application of the CRA methods to 26 different risk factors that were summarized in The world health report 2002 and published in full by WHO in 2004. The risk factors for pneumonia included in the global analysis were childhood underweight, zinc deficiency, indoor smoke from household solid fuel use, urban air pollution and tobacco smoking (direct smoking as a risk factor for adult pneumonia). Globally, 55–62% of all pneumonia is attributable to exposure to these risks, the proportion among children under five years of age being higher. Suboptimal breastfeeding has been included in subsequent analysis (see also the section on nutrition above). The presentation extended the CRA analytics to incorporate future avoidable burden, and applied these techniques to quantifying the health benefits of interventions, using the example of charcoal and petroleum fuels in Africa. The presentation emphasized the uncertainty associated with population level estimates, which are nonetheless necessary for any programmatic or policy applications.

Discussion

In the subsequent discussion it was mentioned that the declining trends in pneumonia formerly observed in most, if not all, regions of the world are closely connected with improvements in risk factors as well as case management of pneumonia. Therefore, there is a need to emphasize that the predicted future "business as usual" decline in most regions (with sub-Saharan Africa having the slowest predicted decline) would occur only if past favourable trends continue, for example as a result of economic growth or targeted programmes.

Next steps

The next steps could, in principle, consist of updating CRA results for pneumonia in children less than five years of age, including updating data on exposure, relative risks, and effects of multiple risk factors. Additional risks, such as passive smoking (environmental tobacco smoke), may also be added.

Comparative impact assessment

Dr Louis Niessen presented the work carried out together with Robert Scherpbier on the impact assessment of preventive and case management interventions for improving child survival in Cambodia. In recent years, a number of effective and cost-effective interventions have been identified that substantially reduce under-five mortality. Nevertheless, coverage by such interventions remains low in many countries. A substantial increase in coverage of key child survival interventions are needed if the fourth MDG is to be achieved. We do not know how many resources are needed to scale up selected (sets of) child survival interventions that reduce child mortality, in particular from pneumonia. Nor do we know whether implementation of the existing and new preventive and curative intervention packages to reduce pneumonia and improve child survival is feasible under future budget scenarios. Likewise, it is unknown how much under-five mortality from pneumonia can be averted in various world regions if (sets of) the most effective intervention options are implemented on a large scale. The presentation outlined the approach to estimating the impact of child survival scenarios in reducing pneumonia mortality. Not all interventions have the same cost–effectiveness. The cost–effectiveness of interventions can be plotted according to the so called "expansion pathways", which range from low cost/low effectiveness to high cost/high effectiveness. Since costs of interventions will vary in different regions (according to their salary and commodity profiles), different expansion pathways can be constructed for different regions. These findings prepare CAH, GAPP and other agencies for an evidence-based policy dialogue on how to achieve the fourth MDG, halve the pneumonia burden and formulate policy options.

The approach uses common standard life tables to estimate burden of disease by age, sex and cause and to calculate health risk and intervention impacts. It has been widely used in Dutch research and also in WHO's CRA project and its generalized cost–effectiveness analysis project (CHOICE). The integrated model life tables use available epidemiological data on risk prevalence and relative risks and disease morbidity and mortality, and the known cost and effectiveness of selected pneumonia interventions. The study outcomes are estimates of likely reductions in mortality, in disability-adjusted life years (DALYs), and of the related cost for each (mix of) intervention(s). Interventions are selected based on the size of the risk-related burden of child mortality, the evidence on the effectiveness from systematic expert reviews, and other recommendations by the GAPP group. Some promising preventive options have been identified: exclusive breastfeeding and promotion of complementary feeding; measures to reduce indoor air pollution; selected nutrition interventions; and vaccine programmes. Also, scaling up of pneumonia case management in neonates and infants, either facility- or community-based, are necessary to reduce child mortality.

The Cambodia results can be presented as a league table of interventions by coverage level. They are used to show possible single-programme expansion paths for neonatal care, facility- and community-based IMCI and promotion of breastfeeding. The example also presents possible combined expansion scenarios, combining preventive and curative options. The study concluded that the concurrent expansion of facility- and community-based IMCI is more cost-effective than scaling up facility-based IMCI alone. Also, it showed that scaling up facility-based IMCI alone does not lead to a detectable reduction in mortality. While counselling on breastfeeding and complementary feeding is very cost-effective, effectiveness is more than doubled when combined with IMCI. Facility- and community-based neonatal care per se are more cost-effective than IMCI alone, but as a single programme are half as effective as when combined with IMCI.

The most cost-effective expansion path for child survival in Cambodia moves from "Exclusive breastfeeding and infant feeding counselling at current coverage" through "Facility and community IMCI at 50% coverage" to "Facility and community IMCI plus infant feeding counselling at 50% coverage" via "Facility and community IMCI plus feeding counselling plus newborn care at 50% coverage" via "Facility and community IMCI and feeding counselling at 95% coverage" to "Facility and community IMCI, feeding counselling and newborn care at full coverage". In spite of the dearth of data and necessary model assumptions, conclusions are robust in probabilistic analysis and confirm other studies. Cost–effectiveness outcomes, disease burden, total cost and affordability, feasibility, equity and responsiveness to expectations have played an equal part in the Cambodian policy debate and in influencing the selection of the child health expansion pathway.

Important gaps

This concluded the individual presentations, and there followed a general discussion of important areas that might be missing. It was stressed that HIV poses particular problems, as does the neonatal age group, and this will need to be covered in the case management papers. The role of *Pneumocystis jiroveci* (previously *P. carinii*) pneumonia, both within and outside the context of HIV, and routine prophylaxis against pneumocystis pneumonia in HIV-exposed children were raised, and it was decided to include these in the case management papers. In terms of preventive interventions for risk factors, participants queried whether other risk factors were not covered, such as outdoor air pollution, environmental tobacco smoke, crowding and chilling. The role of hand washing was also debated. It was concluded that it might be worth commissioning specific reviews on crowding, chilling and hand washing but that it was unlikely, given past experience, that these would turn out to be as important as nutritional risk factors and indoor air pollution. It was questioned whether the scope should be expanded beyond five years of age to cover pneumonia in older children, adolescents and adults. Taking a burden of disease approach, older children, adolescents and young adults were not as important as children under five years of age, and it was decided to omit older adults. Genetic diseases such as cystic fibrosis, which leads to a predisposition for pneumonia, were also briefly mentioned but it was decided to omit those from the scope of the reviews.

DAY 3 | 7 MARCH 2007

Dr Kim Mulholland initiated the session on technical consensus and presented some points for discussion as a result of the first two days of deliberations.

The following points were made during the plenary discussion.

- It would be useful to monitor the expected outcome through some agreed-on indicators.
- An effort should be made to document examples of countries where pneumonia prevention and control strategies have been addressed in an integrated manner.
- Instead of developing new plans at the country level, existing plans should first be reviewed to determine whether pneumonia is being addressed appropriately and how the plans fit in with GAPP activities.
- The long-term consequences for health and mental and physical growth of serious pneumonia episodes in childhood should be studied.
- There is a need to review the effects of crowding and exposure to cold (chilling) as risks for pneumonia.

As a result of this discussion, the participants agreed on the technical consensus statement set out on page 19.

Development of a comprehensive GAPP approach at country level

Dr Shamim Qazi briefly touched on the various aspects of developing a comprehensive GAPP approach at country level, which will take into account advocacy, resource mobilization, implementation, evaluation and research at the country and regional levels. The comprehensive reviews and technical consensus will be used as technical background. The objectives are to (*a*) accelerate overall pneumonia prevention and management, with strategies for scaling up where required, in the context of a child survival strategy; (*b*) propose a set of priority activities that need to be conducted within each area of work in reducing pneumonia mortality; and (*c*) develop an approach to monitoring and documenting the impact of the action plan. The role of GAPP will be: to provide a common platform for various technical groups in working towards improving the prevention and management of pneumonia (through IMCI); to work with and assist organizations, ministries of health and other stakeholders (e.g. the environmental, educational, financial and social sectors) at country level; and to work with international and development agencies and donors at global, regional and country levels. The main areas of work for GAPP have been identified in the technical consensus statement.

For advocacy, a communication strategy at global, regional and local level will be required. The target audience will be: health workers and professionals at global, regional and country levels; international, professional, donor and nongovernmental organizations; and governments. The main communication messages will be: that pneumonia kills more children than any other disease; that effective interventions exist and should be made available to all children; that pneumonia control is a key component of an overall child survival strategy; that multiple interventions working together have greater impact; and that international agencies and national governments should make pneumonia control the centrepiece of MDG activities. The mechanisms of the strategy will be to identify and work with champions for the cause, to meet with policy-makers and key stakeholders, to prepare policy briefs/documents that translate research into policy and implementation, to stimulate greater investment in research and implementation, and to put forward a World Health Assembly resolution to secure the commitment of all WHO Member States.

At country level, potential tasks include (*a*) assisting in identifying synergies among various national programme plans; (*b*) programme implementation, monitoring and evaluation; (*c*) technology transfer to low-resource settings for technical interventions such as vaccination; (*d*) tiered pricing of vaccines, etc.; (*e*) other technologies related to appropriate fuel technology; (*f*) preparation of policy documents to demonstrate the value of pneumonia prevention and management interventions; (*g*) technical assistance for the large-scale introduction of preventive and management interventions; (*h*) documenting country-level models where prevention and treatment interventions have been integrated into broader maternal, neonatal and child health programmes; and (*i*) reviewing existing country data for progress.

Other specific tasks could include advocacy for greater investment in priority research aimed at reducing morbidity and mortality from childhood pneumonia. Examples of potential research would be to: (*a*) identify barriers to and evaluate mechanisms for scaling up interventions; (*b*) study delivery strategies and health-system-related issues; (*c*) carry out formative and market research; (*d*) optimize immunization schedules and study replacement of the pneumococcal serotypes after vaccine use by monitoring changes in the pneumococcal disease epidemiology; (*e*) better understand and describe the etiology and burden of disease; (*f*) identify better meth-

ods to diagnose, prevent and treat pneumonia; (g) examine the cost–effectiveness of adding various effective interventions for pneumonia prevention and management; and (h) address challenges brought about by HIV in relation to reducing childhood morbidity and mortality, considering that 40–50% of pneumonia in many of the high-burden HIV countries occurs in HIV-infected children.

Discussion

During the plenary discussion, the following points were made.

- Greater investment needs to be made in developing a communication strategy to draw more attention towards pneumonia as the largest killer of children.
- Advocacy is needed for recognition as well as implementation. UNICEF is to strengthen communication as part of its child survival strategy, which will include pneumonia. PneumoADIP and The Hib Initiative are already contributing to this effort and will do more. Organizations such as the Gates Foundation, the International Pediatric Association and country-based professional societies should be approached to become more actively involved in communication strategies. Save the Children (United States) is about to celebrate its 75th anniversary, and pneumonia control could form a high-visibility event as part of the celebrations.
- The Child Health and Nutrition Research Initiative (CHNRI) has supported a systematic methodology for setting research investment priorities, focusing on equitable reduction of deaths at scale. CAH is working with CHNRI to identify research priorities for pneumonia among other child health issues. The methodology quantitatively assesses five key dimensions of research: answerability in an ethical way; efficacy and effectiveness; deliverability and affordability; maximum potential to reduce disease burden; and effect on equity.

Theme issue on childhood pneumonia

Dr Hooman Momen, Editor of the *Bulletin of the World Health Organization* (WHO *Bulletin*), explained that its mission is to publish and disseminate scientifically rigorous public health information of international significance that enables policy-makers, researchers and practitioners to be more effective; it aims to improve health, particularly among disadvantaged populations. The contents of the journal include editorials, research, policy and practice, public health reviews, round tables, perspectives, public health classics, reviews of books and electronic media, and letters. Occasionally, the WHO *Bulletin* produces a special theme issue on a topic of public health interest. Pneumonia is such a potential area. To consider the production of the special issue, an outline covering the background, the importance of the area and a potential list of articles needs to be submitted to the editorial board of the WHO *Bulletin* for consideration. If the board agrees, the submissions would go through the standard peer review process.

Discussion and action

It was agreed to submit an outline for a theme issue to the WHO *Bulletin*.

World Health Assembly resolution

Dr Thomas Cherian briefed the meeting on the process of preparing a World Health Assembly resolution. The Executive Board of WHO prepares the provisional agenda of each regular session of the Health Assembly after considering proposals submitted by the Director-General. For GAPP to be considered by the Executive Board as a potential agenda item, a proposal needs to be submitted to the Director-General's office via the Assistant Director-General of the cluster concerned. During the selection process, GAPP may have to compete with other items for a place on the agenda. With good-quality supportive documentation, a strong case can be made for selection. The final documents and draft resolution will have to be ready by November for discussion in the Executive Board's meeting the following January, when the Health Assembly's provisional agenda is decided. The Health Assembly would then consider the draft resolution in May.

The objective of the resolution would be to increase the visibility of pneumonia among policy- and decision-makers at country level. It was felt that the resolution would place pneumonia prevention and management among the priorities in WHO and other global health organizations, and was likely to introduce it into national health agendas. In preparing for the resolution, one should first finalize the technical consensus on the interventions to be used and how they may be prioritized. This will provide the technical basis and rationale for the GAPP and will assist in making a case for including the draft resolution on the Health Assembly's agenda. Second, a document on GAPP should be prepared for the Health Assembly. This should include an explicit strategy(ies) comprising a set of recommended interventions (prioritized and/or sequenced) for introduction and scaling up (including options for financing), realistic goals, indicators and milestones to monitor progress, and follow-up activities. Finally, companion documents and tools should be prepared to facilitate the implementation of the proposed strategy.

Discussion

As the preparation of background and supporting documents will need time to be prepared, it would be prudent to aim for a World Health Assembly resolution in 2009.

General discussion on GAPP

There followed a general discussion on GAPP and its approaches, during which the following points were made.

- There is a need to lay out some principles to see how the various technical groups can work together for the prevention and management of pneumonia.
- It was agreed that the current consultative meeting was an achievement in itself and a good first step towards the harmonization of various efforts in this area.
- The technical consensus statement will act as the common ground to work together.
- It is necessary to inform each other of the areas in which the various technical groups can work together in a horizontal as well as an integrated manner.
- It is important to communicate the importance of pneumonia regarding morbidity and mortality in children.
- It is essential to highlight the value of GAPP in the prevention and management of pneumonia in the areas of:
  - national-level planning
  - policy-level documents
  - assistance in implementation
  - evaluation, surveillance and monitoring of its impact on pneumonia.
- Health systems need strengthening, particularly for standard ARI case management through IMCI.
- Since programmes are implemented by the same health worker/outlet at community level, the standard case management can be linked with vaccinations.

Outcomes of the meeting

I. REVIEWS

There was agreement on a list of reviews that would be undertaken and the experts who will undertake them. These reviews will be submitted to a peer-reviewed journal to be published as a special issue. A list of the topics and the experts who will lead them is given below.

Epidemiology and etiology of pneumonia

Harry Campbell, Igor Rudan

This review will provide a global overview of pneumonia incidence and mortality, with emphasis on the disease burden caused by pneumococcus, Hib and RSV. The review will update work in the context of CHERG on pneumonia incidence and mortality, and use vaccine probe studies as an alternative way to measure the burden of Hib and vaccine-type pneumococcal pneumonias. It will include an attempt to estimate the burden of RSV by collecting data from large studies that provided a community base to hospital studies, many of these coming from vaccine trials.

Prevention of pneumonia through vaccination

Shabir Madhi, Orin Levine, Rana Hajjeh

This review will look at the impact of existing vaccines against measles and pertussis and their scaling up, and that of the new vaccines against pneumococcus and Hib on pneumonia reduction strategies to scale up vaccinations. It will take the vaccine probe estimates of burden forward to estimates of impact and its cost.

Prevention of pneumonia through nutritional interventions

Laura Caulfield, Robert Black

This review will summarize the nutritional risk factors for pneumonia (lack of breastfeeding, micronutrient deficiencies, and wasting and stunting) and their effect on pneumonia mortality and incidence, and experience with nutritional interventions on pneumonia. The nutrition paper will use data from the reanalysis of the burden of disease related to nutritional conditions, including both direct effects in regard to sequelae and the above-mentioned conditions acting as a risk factor for mortality and morbidity from other causes, such as infectious diseases. The data will be based on WHO's 2004 revision of the GBD and nutritional risk factor analyses for underweight, stunting, wasting, deficiencies of iron, iodine, vitamin A and zinc, and suboptimal breastfeeding. The outcomes will be expressed as disease burden in DALYs attributed to these nutritional conditions and attributed child deaths.

Prevention of pneumonia through interventions addressing indoor air pollution

Kirk Smith, Nigel Bruce

This review will summarize the evidence of an effect of air pollution on pneumonia, possible interventions to reduce exposure to air pollution, and evidence of the effectiveness of such interventions. The systematic review and meta-analysis of indoor air pollution originally carried out for the WHO comparative risk assessment will be updated in the light of (*a*) additional studies, including the randomized controlled trial in Guatemala; (*b*) inclusion of studies published in foreign languages, if available; (*c*) the contemporary requirement that systematic reviews could be carried out using independent application of criteria for eligibility, quality assessment and data extraction; and (*d*) meta-analysis, including appropriate sensitivity analyses.

Community case management of pneumonia

David Marsh

Where access to health facilities is a problem, community case management can fill the gap. The article will review community case management strategies and their impact on pneumonia mortality, and how they can link up with the normal health system. The purpose is to describe the policy and programmatic situation of community-based pneumonia treatment in countries, given that the strategy is accepted – indeed essential – for inaccessible communities in poor countries. A brief summary will first be made of the evidence for the impact of community-based pneumonia treatment. Then, results will be tabulated from a 60-country "policy and practice" survey to characterize policies in high-mortality countries regarding on the role of health workers in treating pneumonia (orally) or neonatal sepsis/pneumonia (parenterally). It will include indicators of programmatic scale (population covered), scope (diseases treated), quality (whether monitored) and future plans. In addition, 3–5 country briefs to detail selected policy and programme profiles will be presented.

Pneumonia case management at health facilities

Steve Graham

As summary will be made of the effect of case management on pneumonia mortality, covering improved case management at the first-level facility and in hospitals with antibiotics, and provision of oxygen to hypoxaemic children.

Case management of pneumonia in high-HIV settings

Steve Graham, Shabir Madhi

HIV has a major impact in pneumonia case fatality and the etiological spectrum of disease. It is a major issue to address in terms of case management and the evidence on the impact of interventions.

Comparative risk and intervention assessment

Louis Niessen, Majid Ezzati

Combining the individual papers on risks and on interventions, the review will compare the impact of the individual risks covered in the reviews on pneumonia, and how different interventions can address this. This will build on the comparative risk assessment methodology used for *The world health report 2002*, but will be updated and with an outcome of pneumonia mortality. The second part will break new ground by looking at interventions, their cost and the respective

benefits, such as case management in the presence of high vaccine coverage against Hib or air pollution and nutritional interventions combined.

Pneumonia and equity

Kim Mulholland

Pneumonia disproportionately affects lower social classes and rural populations with poor access to the health system. In this review, we will present the issue of inequitable access and how it affects the application of child survival interventions. It will begin with a brief review of the literature on inequitable access to health care and its impact on pneumonia mortality and child mortality in general. The analysis will not be restricted to wealth indices, but will also address the issues of geographical access to health services, ethnographical inequities, and the impact of health service quality. Some new data will be presented, which may arise from work on the new round of UNICEF Multiple Indicator Cluster Surveys (MICS) and/or an analysis of a recently completed study from the Gambia, which is addressing this issue. The review will end with a proposed approach to addressing this important area.

Other areas

Two other areas that need to be reviewed are the role of crowding and chilling on the prevalence and incidence of pneumonia. Reviewers need to be identified to study these areas.

II. TECHNICAL CONSENSUS STATEMENT

The following consensus statement was agreed on, and should be used widely for advocacy purposes and to help promote the global action plan.

- Pneumonia kills more children than any other illness in the world. Pneumonia is a significant problem in communities with a high rate of under-five mortality, and places a huge burden on families and the health system. Pneumonia control is therefore a priority and is essential in achieving the fourth MDG.
- In the context of child survival strategies, countries should develop plans for controlling pneumonia. The key strategies for pneumonia control are:
  - case management with IMCI at all levels
  - vaccination
  - improvement of nutrition/low birth weight
  - control of indoor air pollution
  - prevention and management of HIV infection.
- Priority should be given to applying the strategies first in those countries with the highest current rates of child pneumonia and highest mortality.
- These interventions, if implemented, have the potential to reduce pneumonia mortality and morbidity by more than half.
- Effective case management at the community and health facility levels is an essential part of pneumonia control. Countries with significant rates of under-five mortality should adopt plans to expand adequate case management of pneumonia following IMCI at hospital, health facility and community levels to achieve 90% coverage within a predetermined time frame.

- All countries should take steps to achieve Global Immunization Vision and Strategy (GIVS) targets for measles and pertussis containing vaccines; countries that have not yet done so should add Hib and conjugate pneumococcal vaccines to their national immunization programmes, especially if they have high child mortality.
- Promotion of exclusive breastfeeding and appropriate complementary feeding are an important element of pneumonia prevention. Strategies to reduce rates of low birth weight and malnutrition will prevent pneumonia and should be encouraged.
- Indoor air pollution increases the risk of pneumonia. New technologies can reduce indoor air pollution, and additional research is needed to demonstrate the health benefits of these interventions. Strategies to reduce indoor air pollution may prevent pneumonia and should be encouraged.
- Strategies to prevent mother-to-child transmission of HIV and to improve the management of HIV infection and *P. jiroveci* (previously *P. carinii*) pneumonia prophylaxis in children should be promoted in countries where HIV is prevalent.
- Other preventive strategies, such as encouraging hand washing, should be promoted.
- Pneumonia is a common and serious consequence of pandemic influenza. Preparedness for pandemic influenza should include prevention and control of pneumonia and adds urgency to community case management.

III. NEXT STEPS AND TIMELINES

At the conclusion of this first consultative meeting, the following next steps were agreed on.

1. A request for a special issue on pneumonia will be submitted to the WHO *Bulletin*. If the request is accepted, a special issue is envisaged in the middle of 2008.
2. Drafts of the comprehensive reviews are to be completed by the first week of October 2007.
3. The next consultative meeting will take place in early 2008. Along with discussion of the comprehensive reviews, approaches to further developing the GAPP for country implementation will be identified in consultation with the participants at the meeting. Participants will include technical experts in various fields of pneumonia, national policy- and decision-makers and programme personnel, WHO and UNICEF staff, donors and other stakeholders.
4. Efforts to mobilize the necessary resources for the consultation and to assist with preparation of the background documents for the World Health Assembly will be undertaken by WHO and UNICEF in collaboration with other partners. Discussions on the proposed Health Assembly resolution on pneumonia will be held at the meeting.

All involved will discuss the GAPP approach with potential funding and donor agencies to find partners for pneumonia control activities in countries.

ANNEX 1

Programme

DAY 1		
08:30–08:45	Registration	
08:45–09:00	Welcome and introductions	*Jose Martines*
09:00–09:15	Objectives of the meeting/overview of the agenda	*Renée Van de Weerdt*
09:15–10:45	Epidemiology and etiology of pneumonia 30-minute presentation followed by discussion	*Harry Campbell/ Igor Rudan*
10:45–11:00	Coffee/tea break	
11:00–12:30	Prevention through vaccination 30-minute presentation followed by discussion	*Shabir Madhi/Orin Levine/ Rana Hajjeh*
12:30–14:00	Lunch break	
14:00–15:30	Nutrition (breastfeeding, macronutrients and micronutrients) 30-minute presentation followed by discussion	*Laura Caulfield/Robert Black*
15:30–16:00	Coffee/tea break	
16:00–17:30	Indoor air pollution	*Nigel Bruce/Kirk Smith*
DAY 2		
09:00–10:30	Case management 30-minute presentation followed by discussion	*Steve Graham/David Marsh*
10:30–11:00	Coffee/tea break	
11:00–12:30	Comparative risk assessment 30-minute presentation followed by discussion	*Majid Ezzati*
12:30–14:00	Lunch break	
14:00–15:30	Comparative impact assessment 30-minute presentation followed by discussion	*Louis Niessen*
15:30–16:00	Coffee/tea break	
16:00–16:45	Important gaps and how to address them	*Martin Weber*
16:45–15:30	Publication approach	

DAY 3		
09:00–10:30	Comprehensive approach to pneumonia at the country level	*Renée Van de Weerdt/ Orin Levine/Kim Mulholland/ Shamim Qazi*
10:30–11:00	Coffee/tea break	
11:00–12:30	Refining the Global Action Plan and way forward (Advocacy, resource mobilization, country implementation, evaluation, role of steering group, etc.)	*Renée Van de Weerdt/ Orin Levine/Kim Mulholland/ Shamim Qazi*
12:30–14:00	Lunch break	
14:00–15:30	World Health Assembly resolution	*Thomas Cherian*
15:30–16:00	Coffee/tea break	
16:00–17:00	Summary and distribution of work	*Cynthia Boschi-Pinto*

ANNEX 2

List of participants

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Robert Black, Brian Greenwood (Chair of the review group) and Neff Walker were unable to attend the meeting.

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