

# The Implementation Of The Pneumococcal Vaccine For Children Under 5 In Southeast Asia

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**Abstract-** Pneumonia accounts for over 500,000 (19%) of deaths in children under 5 in the Southeast Asian Region, which is higher than notoriously deadly diseases such as malaria, measles, and HIV/AIDS (Rudan et al., 2008). By examining the challenges this region could have with the implementation of preventative methods (i.e. widespread vaccinations and educating natives), in combination with practices of non-profit organizations in other regions and with other diseases (i.e. GAVI Alliance, Expanded Program on Immunization), this research will aid in finding a cost-effective introduction of pneumonia vaccinations and other methods of combat with this disease in Southeast Asia.

## 1 Introduction

**1.1** Increasing access to vaccines around the world has been a major health care goal for decades. Much emphasis has been placed on developing and distributing vaccines for those in African countries, as many humanitarian organizations highlight the poverty in the continent since there is such a high mortality rate for people of all ages. In deciding diseases to research, pneumonia causes more childhood mortalities each year than AIDS, malaria, and measles taken as a whole (Adegbola, 2012). In 2006, two main organizations that target world health, the United Nations Children's Fund (UNICEF) and the World Health Organization (WHO), stated that pneumonia is the "forgotten killer of children" (Adegbola, 2012). Furthermore, there are about 156 million new cases of childhood pneumonia each year, and 61 million of those cases occur in the Southeast Asian Region, or SEAR (Ghimire et al., 2012). SEAR includes Malaysia, Indonesia, Singapore, Philippines, East Timor, Brunei, Cambodia, Laos, Myanmar, Thailand and Vietnam. Moreover, Southeast Asia has the highest rate, with about 2.6% of all children dying from the disease (Rudan et al., 2008). The actual number of deaths is most likely higher than the predicted values due to long term effects of untreated cases of pneumonia (Ghimire et al., 2012). Inadequate treatment, namely, lack of doctors and vaccinations, leads to elongation of disease time. Even if affected children are able to receive some medication, they often do not receive enough to completely eliminate the disease. Thus, the illness persists and relapse can occur. Furthermore, pneumonia causes symptoms such as bad cough and fever, that if untreated, can lead to other illnesses that can eventually cause death. These factors, however, are indirectly caused by pneumonia and are not included in death counts.

**1.2** Distributional methods need to be addressed to target the poor in the rural areas of Southeast Asia because there is a stark difference between the percentage of children dying in rural areas compared to urban areas (Rudan et al., 2008). This phenomenon could be due to a variety of factors, including unsanitary living conditions, more intensified poverty, and further distance to travel to access health providers. By starting with funding from nonprofits and eventually gaining governmental support, increasing the distribution of the pneumococcal vaccine distribution will help curb childhood mortality in Southeastern Asia.

**1.3** Although many have heard of pneumonia, the public idea of the disease is very muddled. Pneumonia is a disease of the lungs, and the body's air sacs become inflamed and filled with fluid, making it hard for the infected person to breathe. Additionally, sick people may experience fever and other such symptoms, causing the illness to have very severe implications if untreated. There are two main infections that cause the disease coined pneumonia: *Streptococcus pneumoniae*, a bacteria, contributes to the majority of pneumonia cases that affect children (Adegbola, 2012) and *Haemophilus influenzae* type b (Hib), a virus, is another major contributor to the prevalence of pneumonia in children (Adegbola, 2012). Furthermore, because the viral strain of the disease is so common in children, it is important to address the specific properties of a viral infection. Mainly, viruses are nonliving; thus antibiotics do not work as treatment. Therefore, early vaccination is the most important method to curb the disease.

**1.4** All viruses and bacteria have different physical structures, requiring different modes of attack to the immune system. Thus, the vaccine needs to address the pathogen's specific makeup in order to target the immune response. The pneumonia bacteria itself contains a capsule with a specific polysaccharide (Greenwood et al., 2012). A polysaccharide is a "long chain of sugar molecules that make up the cell wall of certain bacteria" ("Principles", 2015). There are many different ways these sugar molecules can be arranged, giving the bacteria unique properties. As cited in "Introduction: Vaccines and Global Health", written by Greenwood et al., there are over 90 different polysaccharides, each with a slightly different effect on the host cell. The body must have specific immune cells to fit that exact configuration of the sugar molecules. This diversity in strains of the disease makes it difficult to treat, as structural differences in the pathogen greatly change how the body reacts to the pathogen. Certain polysaccharides infect humans at a much higher rate than others; vaccines, therefore, must be targeted to include these strains (Adegbola, 2012).

**1.5** Scientists have recognized that the percentage of certain strains of the pneumonia indicate that a vaccine specifically targeting them would be more effective than working to develop a vaccine for all 90 strains. The main vaccines target about 10 to 13 strains of the *S. pneumoniae* virus (Greenwood, 2012). By vaccinating against just these few strains, approximately 80% of all cases of pneumonia are protected against (Greenwood, 2012). Furthermore, scientific research indicates that 50% of childhood deaths associated

with the disease can be prevented by the administration of the pneumococcal vaccine and the Hib vaccine (Greenwood, 2012). Southeast Asia lacks both the resources and money to get the vaccines. Due to these alarming statistics, policy makers must figure out ways to increase the scope of patients with access to these vaccines.

**1.6** Besides increasing distribution, development of more effective vaccines must be addressed as well. As with most other common vaccines, research is still ongoing as to incorporating more strains of the virus into one vaccine. There are vaccines being developed that encompass prevention against more proteins (Adegbola, 2012). More importantly, however, the methods of actual administration of the vaccine need to improve in Southeast Asia. In the developing world, methods and practices of administration often are not optimal; clinics may be unclean and doctors may be inexperienced. Additionally, due to the lack of available information worldwide regarding the disease's prevalence and the high associated cost, distributing the pneumococcal vaccine has been much harder (Adegbola, 2012). An average flu shot, for example, costs an estimated US\$10, whereas the pneumonia vaccine is around \$30. Funding from the Global Alliance for Vaccines and Immunizations (GAVI) and the Advanced Market Commitment (AMC) has allowed distribution in third world countries to accelerate (Adegbola, 2012). We propose that non-profit emphasis on the disease is key to a reduction in the disease's prevalence.

## 2 Challenges

**2.1** The population distribution and geographic situation of the Southeast Asian Region pose several challenges. One fourth of the world's population is located within SEAR, yet each year there are 9.8 million un-immunized children ("Protecting People", 2013). Of these children, many are unable to access immunization services due to either geographic or sociocultural isolation. Many people live in rural areas far away from these services, some are in urban areas but are socially marginalized, and others, due to their beliefs or practices, are ignorant of the benefits of immunizations and thus do not seek it ("Protecting People", 2013). Even if a child is able to receive a vaccine once, he or she may be incapable of returning for suggested following doses of the vaccine. WHO recommends the vaccination schedule for the Pneumococcal Conjugate Vaccine, or the PCV, to either be three primary doses or two primary doses with one booster (2p+1) ("Introduction of Pneumococcal Vaccine", 2013). For the latter option, the primary doses should occur by six months of age, and the booster between nine and fifteen months ("Introduction of Pneumococcal Vaccine", 2013). However, in other studies analyzing drop-out rates (not confined to SEAR), drop-out rates were significant with boosters occurring when the child is a toddler, as the child is too big for the mother to carry and too young to walk; this may also be the case also within SEAR (Henderson, 1984). While primary doses can achieve much for protection from pneumonia, full coverage can only be obtained through all of the doses.

**2.2** Another issue faced when attempting to provide coverage through routine immunization services to such a

large population is a lack of medical resources. While these resources are available through accelerated disease control initiatives, routine immunization coverage often has to compete with disease control issues of greater importance ("Protecting People", 2013). Contributing to this issue of obtaining resources is also that of governments or districts not fully making use of those resources provided by the accelerated disease control initiatives ("Protecting People", 2013).

**2.3** District-level issues are also a significant factor in impeding implementation of vaccines. One of these issues is the need for greater management through more managers and managerial skill, an issue which was cited by the World Health Assembly as the largest barrier for immunization coverage programs with goals similar to ours (Henderson, 1984). Without sufficient managerial capacity, which could be simply gained through hiring and training of residents of SEAR, there is a lack of supervision, monitoring, and communication, leading to poor regulation of the immunization services ("Protecting People", 2013). The adverse effects following immunization (AEFI) are of large importance, and without proper management, organization, and communication, AEFI and public knowledge of AEFI can really hurt immunization activities ("Third Meeting", 2012). There is a real need at the district-level for an increase of education about vaccines. Often among those making the policy decisions, there are people who need to be educated about the benefits of a vaccine, both in protection from a virus within an individual, as well as in a national decrease in mortality and increase in health level (Ghimire, 2012).

**2.4** The success in implementation of vaccines is also largely dependent on a good health system. A national immunization advisory committee allows for good decision-making, and without one, introducing a vaccine is impeded by poor planning and financial issues (Hajjeh, 2011). While SEAR does have a national immunization advisory committee, the Southeast Asian Region Immunization Technical Advisory Group (SEAR ITAG), which first met in 2008, as of 2012 had mostly only addressed measles, Japanese encephalitis, rubella, and polio, and had not done much to assist the implementation of PCV ("Third Meeting", 2012). Most citizens of the low-income countries in SEAR are not able to pay for these PCV vaccines, and when combined with the country's inability to financially support routine immunization coverage due to disorganized health systems (Hajjeh, 2011), the cost of these vaccines becomes a big issue.

**2.5** Despite the high amount of childhood mortality caused by pneumonia in SEAR, most families still do not have enough incentive to buy vaccines due to other immediate issues, such as lack of food and tax debt. Therefore, the responsibility for these vaccines goes to the many inadequate health systems and uneducated decision-makers, or otherwise toward the creation of more cost-efficient vaccines.

**2.6** Another possibility of increasing vaccine supply and therefore decreasing cost of newly introduced vaccines in SEAR is to increase production of PCV in the region ("Introduction of Pneumococcal Vaccine, PCV13, A Handbook for District and Health Facility Staff", 2013).

### 3 Examples of Successful Implementation

**3.1** Non-profit organizations, like GAVI, and agencies, such as WHO, have had success in the dissemination of an array of vaccines in resource-deficient regions as a preventative measure for leading causes of death. By examining the effective methods of the aforementioned institutions, we will be able to find methods that could be applied to the efficient distribution of the pneumococcal vaccine to children under 5 in SEAR.

**3.2** One of the biggest obstacles for the dispensation of vaccines in developing countries is making the method cost-effective and continuously financed, so it could work effectively over a long period of time. An example of successful financing is the system of the non-profit Global Vaccination Alliance, founded by Bill and Melinda Gates (GAVI, 2013). The Alliance has four sources for sponsorship, which include: public-private partnerships with corporations, private individuals and foundations, a steady stream of committed pledges and donations, and the services of the International Finance Facility for Immunization (IFFIm) and Advanced Market Commitment (AMC), which sell “vaccine bonds” in capital markets (IFFIm, 2015). The aforestated means of sponsorship will be difficult to implement in developing countries, which is why the main takeaway from this example should be that global and notable non-profit organizations might be more successful in spreading the pneumococcal vaccine in SEAR.

**3.3** In the 2013 progress report, GAVI published its biggest “market-shaping success” (GAVI, 2013) in reducing and stabilizing the prices of three vaccines: the Human Papilloma Virus Vaccine (HPV), the pentavalent vaccine and the pneumococcal vaccine. The lowering of price was achieved with a well-researched financial plan that promised a long-term and stable income to potential manufacturers, which enticed them to accelerate production of vaccines (GAVI, 2013). In fact, the Alliance was able to support the launch of production of the pentavalent vaccine by domestic manufacturers in Indonesia. However, the organization is only present in Myanmar, Laos, and Cambodia (GAVI, 2013). One could assume that since the methods were implemented in some parts of SEAR, they could be introduced to the others as well. This could be achieved with region-specific research, which will forecast a steady income for local manufacturers of the pneumococcal vaccine. The research should also be promoted within the population (in schools, hospitals, public spaces, etc.) in order to increase awareness of the problem.

**3.4** Another example is exhibited in GAVI's success in implementing the Hib vaccine during the period of 1986 to 2010 in low-income areas of the world. Throughout the 10 year delay for developing countries, a continuous flow of funding and cost effectiveness, among “limited awareness, communication, uncertainty in importance of problem” (GAVI, 2010) were pivotal concerns. GAVI was able to bypass the obstacle of sponsorship by getting a USD 37 million dollar grant, which allowed it to subsidize the vaccination for resource-deficient regions, thus increasing accessibility to the preventative treatment (GAVI, 2010). Additionally, research

and analysis from a variety of services such as the Johns Hopkins Bloomberg School of Public Health and the Centers for Disease Control and Prevention (CDC) helped reinforce the importance of the vaccination project to manufacturers and the general population (GAVI, 2010). By 2010, the dedicated agency for the cause prevented an estimated of 430,000 deaths by disseminating the Hib vaccine in 62 countries, nearly all of which were low-income (GAVI, 2010).

**3.5** The Expanded Programme on Immunization (EPI), an agency of the WHO, was established in 1977 with the goal of making vaccines available to children around the world (WHO, 2013). Additionally, the motivation behind its establishment lies as a stepping stone in WHO's “strategy to achieve health for all by 2000” (WHO, 2013). Even though the previously mentioned global target was not achieved, the EPI was still successful in the global distribution of vaccinations to children. The tangible results include 86% of infants vaccinated with three doses of the DTP vaccine in 2014 (WHO, 2015), a 75% drop in global measles deaths stemming from the Program's dissemination of the Measles, Mumps and Rubella (MMR) vaccine, and the spread of EPI's support, which encompasses 37 countries in the present (WHO, 2015). Despite all the success, the EPI has not been able to accelerate the delivery of pneumococcal vaccines, especially to Southeast Asia, and instead focuses on “promoting breastfeeding... preventing pneumonia prophylaxis ... and procuring adequate care” (WHO, 2014).

**3.6** In 2014, the Croatian Ministry of Health examined whether country-wide implementation of the PCV vaccine would be cost-efficient, considering the country's statistics, such as necessity, access, and interest, based on a projected time-frame of 2014 to 2033 (Višekruna et al., 2015). The main outcomes of this research are a target price and a favorable vaccine: US\$ 20 per dose of PCV 10 (Višekruna et al., 2015). Similar research, which considers all factors and challenges in the SEAR, could be conducted in order to find the most cost-efficient pneumococcal vaccine and its price. The latter would allow a notable non-profit to know the extent of subsidization needed for the successful distribution of the vaccine in Southeast Asia.

**3.7** An illustration of a successful collaboration between a non-profit with a developing country's government presents itself in GAVI reaching Mongolia, specifically its children, in distributing the DTP3 vaccine, while getting financial support from a “special immunization fund, which (drew)... most notably from income taxes” (GAVI, 2013). A promotional campaign for tax-paying with direct motivation for country-wide vaccination for children, accompanied by transparency within the country, as well as the organization, allowed for the spread of the project and its successful implementation: by 2012, 99% of children received their DTP3 vaccination. The same method could be applied in the Southeast Asian region, as its economies are among the fastest growing in the world, and paying taxes has become more regular overall (Lexology, 2014). If the governments ease into implementing the methods for successful distribution of pneumococcal vaccines, the success would become much more long-term.

**3.8** After the examination of the immunological successes, especially those featuring the Global Alliance, one could

speculate the reasons why the organization is not more active in the SEAR, particularly in preventing pneumonia, even though the disease is the leading cause of child mortality (almost a fifth, according to WHO). Whether the organization's goals of global immunization are too ambitious, or the countries are unwilling to cooperate due to prioritization of food and resource provision, there is a need for an accelerated program that would target this specific population in order to combat the problem.

#### 4. Systematic Changes

**4.1** Beyond having countries get the aid of non profit organizations, government funding must be addressed. Getting the financing out of the way will avert the focus from curative services to preventative services i.e. vaccines. GAVI has already recommended budgeting towards the cause, but it is the responsibility of national governments to allocate substantial money towards immunisations (Levine et al., 2006).

**4.2** A strong approach for change would be to look at developed countries as framework. Looking at countries that have a functioning health care or immunization system gives developing countries, such as those in SEAR, guidelines and a goal. The goal is to reach working administration and an effective routine procedure. Although these sorts of goals may be overly optimistic, simple changes can be made that are realistic to the developing world. The United States is an example where the government has reached sufficient funding and there is a working procedure for the administration of vaccines. Based on United States surveillance data, routine vaccination has caused declines in overall diseases and vaccine-type invasive diseases in children under 2, as well as reductions in vaccine type diseases in unvaccinated children (Levine et al., 2006). This is an example of herd immunity where there are only a few unvaccinated people in a larger population. Less colonisation of vaccinated people occurs, which accounts for less possibility of transmission to those who are unvaccinated. If this method works to the extent of that in the USA, herd immunity can prevent twice the amount of cases just from vaccination alone (Levine et al., 2006).

**4.3** Based on the current method of vaccination there are three types of pneumococcal conjugate vaccines; PCV7, PCV10, and PCV13. The higher the serotype number, the more strands of the disease that are protected against. PCV7 is expected to protect against 50-80% of pneumonia. The strands that are not protected against would in theory become more prevalent, although the majority that are being protected against will greatly decrease. This implies that persistence in administration of vaccines will reduce disease rates substantially. Native Americans are a population that have similar epidemiology in relation to vaccines to developing countries such as SEAR and there is a presence of non targeted disease strands, but few deaths have been recorded due to this rise (Levine et al., 2006). Newer and more advanced vaccines will eventually protect more strands and contain more serotypes. A possible 20 serotype vaccine is on the way and supply and development is sufficient in developing countries (Levine et al., 2006).

**4.4** Beyond the original point of 'Pneumococcal Vaccination in Developing Countries' by The Lancet, a more advanced vaccine with more serotypes would be helpful. PCV13 is a 6 serotype step up from PCV7 making the potential rise of less common strands even less likely. In a California study of 37,000 infants, the PCV7 vaccine prevented 90% of invasive diseases. Also, since the introduction of routine pneumococcal vaccines the 7 strands protected against have declined by 99% in the United States (Centers for Disease Control and Prevention, 2015). This proves that any vaccine would begin to help countries in Southeast Asia. The PCV13 vaccine would just continue to help those affected by the less common strands, which are overall less common. Immunity will be furthered not only with pneumonia but also with meningitis and sepsis, which are protected by pneumococcal vaccines, providing additional health benefits.

**4.5** The nature of the pneumococcal vaccine is important to what systematic changes should be made. The pneumococcal vaccine should be administered to young children at 2, 4, 6, and 12-15 months of age and if they are healthy by the age of 2 only one dose is required (Center for Disease Control and Prevention, 2015). This fact brings up the topic of maternity leave. Research was done on 20 low and middle income countries to see if the amount of guaranteed paid maternity leave had an effect on the amount of vaccinations that are generally administered to newborns. The 3 vaccines analyzed were DTP (diphtheria, tetanus, and pertussis), BCG (Bacillus Calmette-Guérin), and Polio. Polio and DTP are both given in 3 doses (Hajizadeh, Mohammad et al., 2015). The research combined countries' birth records, average amount of paid maternity leave, and vaccine receipts to develop a logistic regression model which showed that DTP vaccine coverage increased with more leave as where Polio did not (Hajizadeh, Mohammad et al., 2015). A possible explanation may be that DTP is administered with doctors and at clinics, but Polio is given at clinics or campaigns. Further research is required to solidify the credibility of this claim (Hajizadeh, Mohammad et al., 2015).

**4.6** These findings are amiable for the pneumococcal vaccine because DTP is administered at similar intervals. The governments in Southeast Asia must take the initiative to make policies that extend the amount of paid maternity leave. This will give mothers more time and fewer problems with getting their children vaccines. As shown with DTP, the addition of a few months can make sure that a child gets their first few pneumococcal vaccines, which would hopefully set the precedent for a child to become fully immunized.

**4.7** The goal is to get policies that increase guaranteed paid maternity leave, so that more children under 5 get their pneumococcal vaccines and eventually these countries reach herd immunity similar to that of developed countries. This would benefit both the people, as they would be immunized and the government as they would have a stronger population with fewer problems. Incentives could be added so that employers will only give leave if mothers get their children vaccinated, which mirrors policies that mandate vaccines. The right amount of time is crucial so that mothers have the opportunities to do best for their family but not put excessive burden on employers. The proper systematic

changes in combination with other help, could pave the road for SEAR to get rid of their pneumonia conundrum.

## 5. Conclusion

**5.1** The strengths of the six examples outlined in section 3 make up the hypothetical method of successful implementation of the pneumococcal vaccine in Southeast Asia. An optimal way to address the distribution of the vaccine is to establish a non-profit organization that has a specific target of reducing child deaths in SEAR by distributing vaccination. The first stage of this organization would be to get sponsorship from donations, pledges, grants etc, in order to achieve the following: forecast the most cost-efficient and effective pneumococcal vaccine for children under five that could achieve full coverage through primary doses without boosters; promote the distribution of the vaccine as an opportunity for a long-term, stable income for manufacturers of the vaccine, especially production in the region; while the market stabilizes with the accelerated production, the sponsorship will allow for subsidization of the vaccine. Another way to get sponsorship would be to partner with an investment firm or financial organization (i.e. IFFIm or the AMC), to sell Southeast Asian Pneumococcal Vaccine Bonds in the capital markets. With a working method in place, the organization should partner with local governments to create policies for the subsidization of the vaccine using tax money, which will ease the program into being a long-term process of action to prevent children's deaths from pneumonia. Other approaches would be to develop policies to maximize the effectiveness of the pneumococcal conjugate vaccine. The government should try to attain the best vaccines within the realm of their budgets and also extend guaranteed paid maternity leave. Countries that have been successful with vaccination can be helpful in providing framework as well.

## Bibliography

- [1] Adegbola, Richard A. "Childhood Pneumonia As A Global Health Priority And The Strategic Interest, Bill & Melinda Gates Foundation." *Clinical Infectious Diseases* 54.(2012): 89-92. Academic Search Premier. Web. 27 July 2015.
- [2] Clemens, John D., and Luis Jodar. "Translational Research to Assist Policy Decisions about Introducing New Vaccines in Developing Countries." *Journal of Health, Population and Nutrition* 22.3 (2004): 223-31. JSTOR. Web. 27 July 2015.
- [3] Edejer, Tessa Tan-Torres, et al. "Achieving the Millennium Development Goals for Health: Cost Effectiveness Analysis of Strategies for Child Health in Developing Countries." *BMJ: British Medical Journal* 331.7526 (2005): 1177-80. JSTOR. Web. 27 July 2015.
- [4] "GAVI Alliance Progress Report 2013." GAVI Alliance Progress Report 2013. N.p., 2013. Web. 29 July 2015.
- [5] Ghimire, M., S.K. Bhattacharya, and J.P. Narain. "Pneumonia in South-East Asia Region: Public Health Perspective." *The Indian Journal of Medical Research* 135.4 (2012): 459-468. Print.
- [6] Greenwood, Brian, David Salisbury, and Adrian V.S. Hill. "Introduction: Vaccines and Global Health." *Philosophical Transactions: Biological Sciences* 366.1579 (2011): 2733-42. JSTOR. Web. 27 July 2015.
- [7] Grijalva, Carlos G. and Kathryn M. Edwards. "Promises and Challenges of Pneumococcal Conjugate Vaccines for the Developing World." *Clinical Infectious Diseases* 43.6 (2006): 680-682. Oxford University Press. Web. 27 July 2015.
- [8] Hajjeh, Rana. "Accelerating Introduction of New Vaccines: Barriers to Introduction and Lessons Learned from the Recent Haemophilus Influenzae Type B Vaccine Experience." *The Royal Society Publishing*. N.p., 05 Sept. 2011. Web. 30 July 2015.
- [9] Hajizadeh, Mohammad, et al. "Paid maternity leave and childhood vaccination uptake: Longitudinal evidence from 20 low-and-middle-income countries." *Social Science & Medicine* (2015).
- [10] Henderson, Ralph H. "The Expanded Programme on Immunization of the World Health Organization." *Reviews of Infectious Diseases* 6.Supplement 2. International Symposium on Poliomyelitis Control (1984): S475-S479. JSTOR. Web. 27 July 2015.
- [11] "Hib Initiative: A GAVI Success Story." - Gavi, the Vaccine Alliance. N.p., 2010. Web. 29 July 2015.
- [12] "Immunizations, Vaccines and Biologicals." WHO. N.p., 2015. Web. 02 Aug. 2015.
- [13] "Introduction of Pneumococcal Vaccine, PCV13, A Handbook for District and Health Facility Staff" (2013): n. pag. Web. 2 Aug. 2015.
- [14] Levine, Orin S., et al. "Pneumococcal vaccination in developing countries." *The Lancet* 367.9526 (2006): 1880-1882. also works for organization and price
- [15] "Overview." - ABOUT IFFIm. N.p., n.d. Web. 29 July 2015.
- [16] Pakistan Pneumococcal Vaccine Introduction. Gavi, the Vaccine Alliance. Gavi, n.d. Web. 27 July 2015.
- [17] Patrick L.F. Zuber, Ibrahim El-Ziq, Miloud Kaddar, Ann E. Ottosen, Katinka Rosenbaum, Meredith Shirey, Lidija Kamara, Philippe Duclos, "Sustaining GAVI-supported vaccine introductions in resource-poor countries." *Vaccine* 29.17 (2011): 3149-54. Science Direct. Web. 27 July 2015.
- [18] "Pneumonia." WHO. N.p., 2014. Web. 02 Aug. 2015.
- [19] "Principles of Vaccination." *Epidemiology and Prevention of Vaccine-Preventable Diseases*. Ed.

Jennifer Hamborsky, Andrew Kroger, and Charles Wolfe. 13th ed. Washington DC: Public Health Foundation, 2015. 1-8. Centers for Disease Control and Prevention. Web. 2 Aug. 2015.

- [20] "Protecting People from Vaccine Preventable Diseases" (n.d.): n. pag. Web. 30 July 2015.
- [21] Rudan, Igor, et al. "Epidemiology and Etiology of Childhood Pneumonia." *Bulletin of the World Health Organization* 86.5 (2008): n. pag. World Health Organization. Web. 27 July 2015.
- [22] SEAR ITAG. "Third Meeting of the South-East Asia Regional Immunization Technical Advisory Group (SEAR ITAG)" (2012): n. pag. Web. 2 Aug. 2015.
- [23] "Taxation in Southeast Asia: An Overview | Lexology." *Taxation in Southeast Asia: An Overview*. N.p., 2014. Web. 02 Aug. 2015.
- [24] "The Expanded Programme on Immunization." World Health Organization. N.p., n.d., 01 December 2013. Web. 28 July 2015.
- [25] V. Višekruna Vučina, S. Kurečić Filipović, N. Kožnjak, V. Stamenić, A.D. Clark, B. Mounaud, J. Blau, C. Hoestlandt, B. Kaić, "Cost-effectiveness of Pneumococcal Conjugate Vaccination in Croatia." *Vaccine* 33.1 (2015): A209-218. Science Direct. Web. 27 July 2015.
- [26] You, Joyce HS, et al. "Cost-effectiveness analysis of influenza and pneumococcal vaccination for Hong Kong elderly in long-term care facilities." *Journal of epidemiology and community health* 63.11 (2009): 906-911. also some systematic