Distribution Agreement

Measles Elimination in Southeast Asia

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Abstract

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Background

The eleven countries of The World Health Organization for South East Asia Region (SEARO) have a target of measles elimination by 2020. Despite having relatively strong measles routine immunization programs and supplementary measles immunization activities measles remains a significant problem in the SEARO countries. In 2012, there were 46,945 reported measles cases in the region, 39.8% (18,668) from India.

Objectives

The objectives of this study are 1) to describe current measles routine immunization, surveillance and measles supplementary immunization activities in the SEARO countries; and 2) to identify key challenges for meeting the measles elimination target by 2020.

Methods

The primary method employed was a thorough document review of both published and unpublished information on all aspects of the measles immunization program in each SEARO country. Additionally aggregate measles data reported to SEARO and made available by CDC were used to show trends in each component of measles activities from 1995 to 2012.

Results

Among the SEARO countries Bhutan, Sri Lanka, Maldives, Thailand and Bangladesh consistently achieve the target of greater than 90% measles immunization coverage. These three countries have maintained high level routine immunization coverage of more than 95% at national and subnational level. India, Indonesia and Timor-Leste are far behind if they are to meet the elimination target. In 2012, measles (MCV) coverage was 74% in India with great variance in coverage among states. Indonesia achieved 80% coverage in 2012 while Timor-Leste only achieved coverage for MCV of 62% in 2012. Nepal has not yet reached coverage of 90% but at 86% is making considerable progress and has conducted measles and rubella (MR) campaigns targeting children 9 months to 15 years of age to reduce the number of measles cases.

Recommendations

Community based micro planning has been shown to improve routine immunization by involving local authorities at every stage of routine immunization and campaigns. High level advocacy is needed for each round of measles campaigns.

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Table of Contents

Introduction

1.1 Rationale

Measles elimination is a critical challenge facing countries in South East Asia Regional Office (SEARO) of the World Health Organization. Over 70, 700 children died of measles in 11 countries of SEARO in 2011 (WHO, 2012). This contributes about 45% of global measles deaths. Measles is a highly contagious disease but it can be eliminated. Elimination of measles is defined as interruption of measles virus transmission within a defined geographic area such a country, continent or WHO, Region. In 1997, the Dahlem conference in Brazil on disease elimination established 4 criteria for disease elimination (Orenstein et al., 2000). The first criteria is that humans must be critical to continuing transmission. The second criteria is accurate diagnostic tools must be available. The third one is an effective intervention must be available. The final benchmark is it must be possible to interrupt transmission for a prolonged period in a large geographic area.

In measles, all these four elimination criteria are met. Humans are the only reservoir for measles. Measles virus can not survive in the environment for a long period of time. However, measles infections have been documented in non-human primates. But, non-human primates do not have sufficient population size to continue measles virus transmission.

For measles elimination activities, clinical diagnosis of measles is not sufficient as many other diseases are similar to measles thus laboratory confirmation is required. For laboratory confirmation a captured enzyme linked immune-sorbent assay (ELISA) test is available. The ELISA test for IgM developed by the Centers for Disease Control and

Prevention (CDC), is a very effective tool for diagnosis of measles as it has specificity of 95% or higher and at least 95% sensitivity.

An effective measles vaccine is available. A single dose of measles vaccine at the age of 9 months provides sero-conversion rate of 85%. If a child gets the second dose of measles vaccine the sero-conversion rate rises to 95%. For measles elimination the threshold immunity of 95% is required to stop transmission. Recent success in measles elimination in Pan American Health Organization (PAHO) provides sufficient evidence for the feasibility of global elimination (Andrus, de Quadros, Solorzano, Periago, & Henderson, 2011).

In September 13, 2013, the 11 member states of SEARO committed to eliminate measles by 2020 at the sixty sixth meeting of the WHO Regional meeting in New Delhi, India (WHO, 2013). Measles elimination activities are already in place in these countries. In 2013 SEARO eliminated polio and this region is committed to eliminate measles as well from this region by 2020. Recent lessons learned from polio elimination in SEARO provide encouragement and motivation that measles elimination can can achieved in SEARO as well. SEARO countries have strong political commitment, WHO commitment for technical assistance, UNICEF support for vaccines and logistics and Global Alliance for Vaccine and Immunization (GAVI) for strengthening routine immunization.

Strategies currently recommended by WHO to achieve measles elimination include: measles routine immunization (RI) coverage of 90% or more at national level with one dose of measles vaccine administered at 9 months of age; implementation of a national catch-up campaign in children aged 9 months to 14 years with coverage of 95% or more; implementation of periodic national follow-up measles campaigns in children aged 9 months to 59 months with coverage of 95% or more at intervals of 3 – 4 years; and the establishment of case- based measles surveillance for laboratory confirmation of measles (WHO, 2010).

1.2 Problem Statement

Measles is one of the leading causes of death among children even though a safe and cost- effective vaccine is available. In the year 2000, WHO estimated that 542,000 children died of measles globally. This burden accounted for 7% of all under five mortality. In some developing countries, case fatality rates for measles among young children may still reach 5-6% (UNICEF, 2012).More than 70,700 children died of measles in 11 countries of SEARO (Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand, and East Timor) in 2011. This accounts for 45% of global measles deaths. SEARO countries have already begun to implement elimination activities. However, routine measles vaccine coverage is still below 80% in India, Indonesia and East Timor. India began supplementary immunization activities (SIAs) in 2010. Even though routine immunization, surveillance and SIAs are in place now in SEARO countries, measles incidence of measles in India, Nepal, Indonesia, Bangladesh and in Thailand is still above 5 cases per million. For elimination purposes measles incidence should be less than 5 per million

1.3. Significance Statement

Introducing measles containing vaccine in routine immunization programs,

starting measles case based surveillance and providing supplementary immunization activities play a critical role to eliminate measles in each SEARO countries. WHO/SEARO has already set the targets for the elimination of measles by 2020. This thesis review highlights the strengths and weaknesses of existing routine immunization programs, defines the various types of existing surveillance activities in SEARO countries and describes the benefits of measles surveillance for other diseases like rubella. Furthermore, this review provides recommendations for improving routine immunization and enhancing quality of supplementary measles campaign. This review of measles elimination activities will provide additional insights for service providers, program managers, policy makers of each country in SEARO and global partners of measles elimination in designing effective programs for measles elimination.

1.4.Purpose statement

The purpose of the present study is to assess the contribution of routine immunization, surveillance and supplementary immunization activities to the goal of measles elimination by 2020 in the countries of the SEARO region.

1.5. Study- Specific aims

- Describe routine measles immunization services (RI) in each SEARO country.
- Define existing measles surveillance activities in each country of SEARO.
- Assess the performance of measles and rubella supplementary immunization activities (SIA) from 1995 to 2012 in each country of SEARO.
- Develop recommendation on how measles elimination activities can be used to strengthen routine immunization services, enhance surveillance and contribute to enhancing the quality of measles and rubella campaigns within health systems.

1.6. Research questions

After reviewing information from all SEARO countries as well as current program performance data, this review will briefly address three research questions.

1. Do other disease surveillance activities, such as rubella surveillance, benefit from the measles surveillance?
2. Can measles case based surveillance help to eliminate measles in SEARO countries?

3. Will measles supplementary immunization activities reduce measles epidemics?

2. Literature review

In this review, we will first describe the clinical significance of measles and its epidemiology, secondly we will review different strategies of measles elimination in developing countries. Finally, we will review the challenges faced by other WHO regions during the measles elimination process. Articles selected for review in this section are ones that focus on research conducted in countries of SEARO.

2.1. Clinical manifestation of measles and its complication (Perry & Halsey, 2004).

Perry & Halsey (2004) published a comprehensive review in the Journal of Infectious Diseases in 2004 with two hundred forty references. The authors describe the clinical manifestation of measles and its complications in developing countries where socioeconomic status is very low and measles spreads quickly in crowded places. Measles morbidity and mortality depend on many factors such as age, sex, socioeconomic status, measles vaccination and case management. Measles is a very contagious infection caused by a virus called measles virus. There is only one type of measles virus. It is spread when an infected person coughs, sneezes. The most communicable period is four days before the rash onset and four days after the rash appears. Measles causes fever, runny, cough and a rash all over the body.

Measles is diagnosed by IgM by ELISA and isolation of virus by culture and polymerase chain reaction (PCR). Measles can lead to serious complications like pneumonia, ear infection, blindness, encephalitis and diarrhea. About one out of 10 children with measles develops an ear infection, up to one out of 20 gets pneumonia, about 1 child in every 1,000 who get measles will develop encephalitis, 8% children with measles infection develop diarrhea (CDC, 2012). Pneumonia is the most common complication and reason for death among children under five in developing countries. Providing vitamin A can reduce the mortality from measles by 30 to 40%. In developing countries blindness is the most common cause of disability caused by measles. This complication can be prevented by treating with vitamin A.

This article also provides clues to reduce measles associated death in developing countries. The goal of measles mortality reduction is to reduce measles mortality by 95% by 2015 compared to measles associated deaths in 2000. The measles virus infects anyone who is not protected. An effective measles vaccine is available in the form of monovalent or in the form of measles, mumps and rubella (MMR) or measles and rubella (MR). In developing countries, due to malnutrition, worms manifestations, frequent acute respiratory infection (ARI) and diarrhea the maternal immunity wanes 6 months after birth. So, vaccination strategy differs from that employed in more developed countries.

Measles complications and death decrease with supportive care, by improving nutritional status, by antibiotics for secondary bacterial infection and by vaccination. Mortality varies from 0.1% to 30% which depends on vaccine coverage, nutritional status, age of infection and access of health care. By reviewing this article many good things can be adopted to eliminate measles in SEARO region by 2020.

2.2. Measles epidemiology and outbreak investigation using IgM test in Laos

(Kuroiwa et al., 2001)

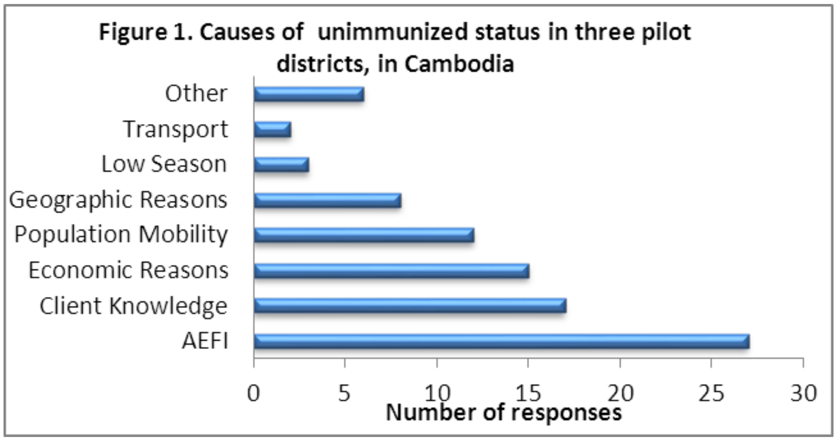
This article describes the importance of measles outbreak investigation and its relationship to routine immunization coverage. In this article, the authors analyzed weekly report from January 1994 to October 2000 with the number of cases and deaths sent from provinces to the National Center for Laboratory and Epidemiology, Laos. From March 1999 to March 2000, 18 large outbreaks (more than 20 cases per outbreak) were reported from provinces by weekly report. Among the 18 outbreaks, the rapid response team (RRT) visited door to door and investigated 7 outbreaks in 5 provinces. Blood samples were drawn from children after consent was given. IgM antibodies to measles were tested in the national laboratory by using ELISA method. The result showed measles positive for 6 out breaks and one outbreak was shown to be chickenpox. Unimmunized children had a three times higher attack rate than immunized children and the case fatality rate was 14% among unimmunized children.

Measles elimination activities were initiated in Laos beginning in 1992. From 1992 to 2000 the average routine measles coverage was 68% at national level. Assuming that a measles mass campaign achieved the same coverage, 95%, as a recent polio campaign, the authors concluded that there would be only an 8% decrease in cases. They concluded that routine immunization coverage should increase to get threshold immunity; only then does a mass campaign produce the level of protection required.

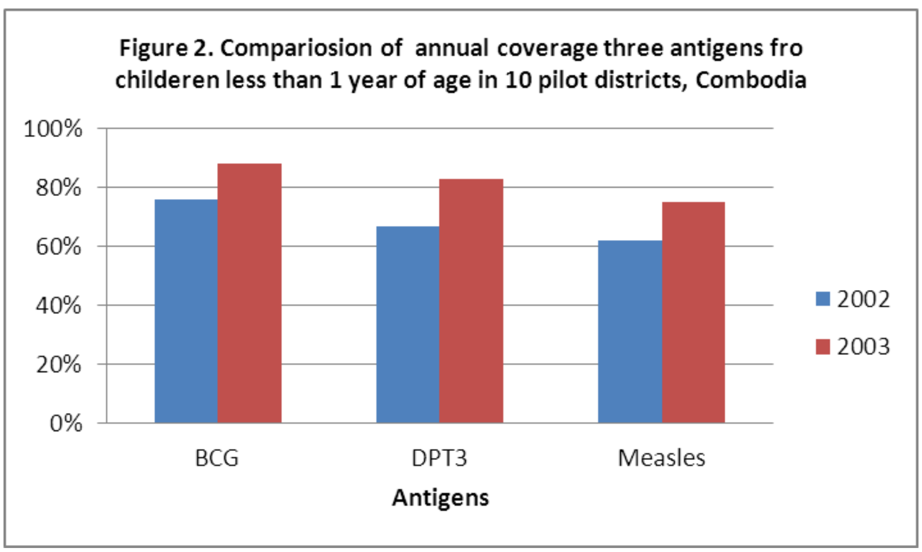
These results are salient for measles elimination stratiges in South East Asia where measles routine immunization coverage is still low in some countries.

2.3. Improving immunization coverage through budgeted microplans and sub national performance agreements: early experience from Cambodia (Soeung et al., 2006)

The authors describe the barriers to improving immunization coverage and propose solutions to overcome these issues by introducing the coverage improvement planning (CIP) process. The CIP includes development of community based micro-plans, investment in social mobilization, securing finance for health outreach and improving monitoring systems. The routine immunization coverage rates were very low in Cambodia, less than 70% for all antigens (BCG, DPT1, DPT2.DPT2, DPT3, OPV1, OPV2, OPV3 and measles), in the year 1998, 1999, 2000, 2001 and 2002. Facing significant problems with routine immunization, the National Immunization Program of the Ministry of Health in Cambodia introduced a CIP program in ten districts as a pilot program. The CIP detected that the most common barriers to having low immunization rates in all piloted districts was adverse events following vaccination (AEFI). The second common reason was lack of client knowledge about immunization due to low education and lack of health education in local languages. The other barriers to immunization were social economic structural issues and behavioral constraints viewed as critical determinants of program failure. Population mobility and geographic reasons were also factors contributing to low coverage (see Figure 1).



This study also compared the pre intervention and post CIP intervention immunization coverage results in ten pilot districts. The following bargraph (Figure 2) shows the mean increase in DPT3 coverage across pilot districts on an annual basis was 16%. These results provide encouraging evidence for the effectiveness of the intervention although differences from a one year pre post study are not robust enough to conclude that the decrease in coverage can be sustained.



The strength of the CIP is it helps to improve immunization coverage and reduces the financial burden for campaign activities. It helps to meet measles elimination criteria for routine immunization when coverage is 90% at national level. The weakness of this program is that it is a vertical program which is good for improving routine immunization but an integrated approach for other health activities will make it more effective.

2.4. Measles Elimination Strategies

2. 4.1. (Biellik et al., 2002) First 5 years of measles elimination in southern Africa: 1996 – 2000:

This article was published in Lancet in the year 2002. The authors discuss the implementation of WHO strategies for measles elimination in seven countries of Southern Africa (Malawi, Namibia, Zimbabwe, Botswana, Swaziland, Lesotho and South Africa). After implementation of WHO measles elimination strategies, the morbidity and mortality from measles reduced drastically in these countries over the period 1996 to 2000.

The World Health Assembly in 1989 set specific goals for the reduction in measles morbidity by 90% and measles mortality by 95% by 1995. The reported measles immunization coverage from 1996 to 2000 was 85% in all seven countries at 9 months of age. A total of 24 million children from 9 months to 14 years of age were vaccinated in seven countries of southern Africa with a coverage rate at 91%. Clinical measles cases declined from 60,000 in 1996 to 117 laboratory confirmed measles cases in 2000. Measles deaths declined from 166 in 1996 to zero in 2000. The article recommended that all seven south African countries conduct follow up measles vaccination campaigns during the period 2000 to 2002 to interrupt measles transmission. This is due to the fact that coverage is not equal to immunity. In measles only 85% of children develop immunity even with 100 % coverage. In this context, 91% of reported coverage protected only 77%

of children in Southern Africa. Thus possible outbreaks are likely after 2001 if there is no follow-up campaign.

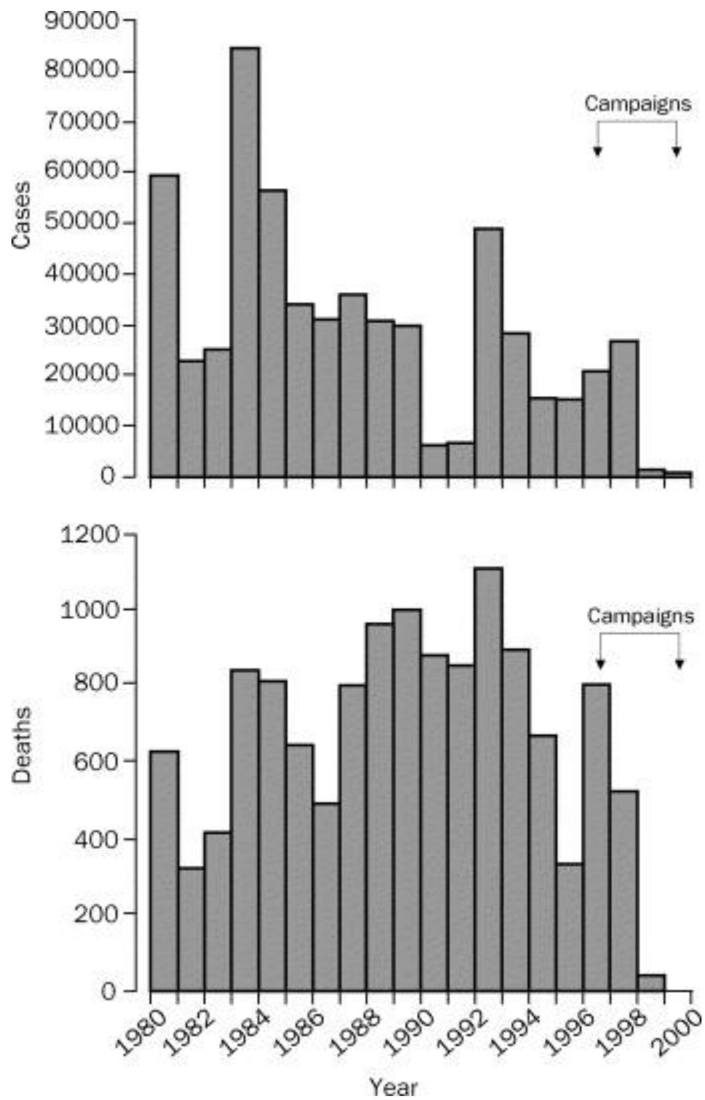


Figure 3. Comparison of measles cases and death after implementation of WHO measles elimination strategies in seven countries of southern Africa

2.4.2 *Lessons and challenges for measles elimination (Minetti et al., 2013)*

In this article, the authors discuss the challenges for measles elimination for those countries who are maintaining measles elimination status. Malawi maintained high routine immunization at 93% and measles mass campaign coverage at 100% in 2008. Despite having this high coverage for measles, in 2010, large measles outbreaks occurred. Malawi conducted a catch up campaign in 1998, follow up campaigns in 2002, 2005 and in 2008 with administrative coverage close to 100%. The required coverage is 95% to interrupt measles transmission in the community. In the 2010 outbreak, 134,000 measles cases and 304 deaths occurred. The authors performed a field survey in Malawi and found problems of ate vaccination for RI as care givers thought that 9 to 11 months of age was too young to vaccinate (36%); a few children (4 %) were not vaccinated due to religious reasons. The standard age for first immunization is 9 months but most of the children were vaccinated from 12 to 23 months of age under the routine immunization program. During SIAs in 2008 only 60% of children were covered. The most affected age groups in this outbreak were infants less than one year of age. The attack rate was highest among children 6 – 8 months, 7.6%, followed by 9 – 11 months, 4.5 %. Below 6 months the attack rate was 2.5 %. The authors came to the conclusion that the strategy used in one country may not apply to other countries and routine immunization program should reach 90% coverage. Conducting catch up campaign targeting only 9 months to 59 months will not be sufficient for measles transmission in the community.

2.4.3. South East Asia Regional update on measles reduction and elimination, 2003 – 2008 (O'Connor et al., 2011)

In 2007, SEARO endorsed a regional strategic plan for measles mortality reduction from 2007 – 2010. The key strategies recommended to achieving this goal for SEARO member countries were : achieve at least 90% coverage of first dose of measles containing vaccine (MCV1) coverage at national level; conduct measles case based surveillance with laboratory diagnosis of every case of measles; conduct measles SIAs with coverage of 95% or more and provide second opportunity of measles vaccine in routine immunization programs.

Measles surveillance in SEARO countries is conducted using a routine reporting system in the form of weekly and monthly reports. If there are no measles cases during a reporting period that indicates zero reports. Another type of surveillance is outbreak surveillance where the report is from detailed outbreak investigations. Each measles outbreak should be investigated and should collect five blood samples from each outbreak and five urine samples to confirm measles associated outbreaks. The third surveillance strategy is measles case based surveillance from designated reporting sites. This requires investigation of each measles suspected case including collecting blood samples for IgM testing. With the exception of India, all other SEARO countries started measles case based surveillance from 2008.

SEARO measles rubella laboratory networks consists of 20 WHO certified laboratories at the following sites: Kathmandu in Nepal; Chennai, Hyderabad, Pune, Ahmedabad and Jaipur in India; Dhaka in Bangladesh; Yangon in Myanmar; Jakarta in Indonesia, Bangkok in Thailand; Thimphu in Bhutan and Pyongyang in DPR Korea. All twenty laboratories are capable of doing IgM testing. Ten laboratories are capable of detecting virus and two laboratories are capable of genotyping.

Routine immunization MCV1 coverage in SEARO countries increased from 63% in 2000 to 78% in 2008. The following table shows the routine immunization schedule in SEARO countries.

Table 1: Routine Immunization schedule in SEARO countries

Bangladesh	38 weeks	Measles only
Bhutan	9 and 24 months	Measles and Rubella (MR)
DPR Korea	9 and 15 months	Measles
India	9 – 12 months	Measles
Indonesia	9 months and 6 years	Measles
Maldives	9 and 18 months	MMR
Myanmar	9 and 18 months	Measles
Nepal	9 – 12 months	Measles
Sri Lanka	9 months and 3yr	MR
Thailand	9 – 12 months and 5 years	MMR
Timor-Leste	9 months	Measles

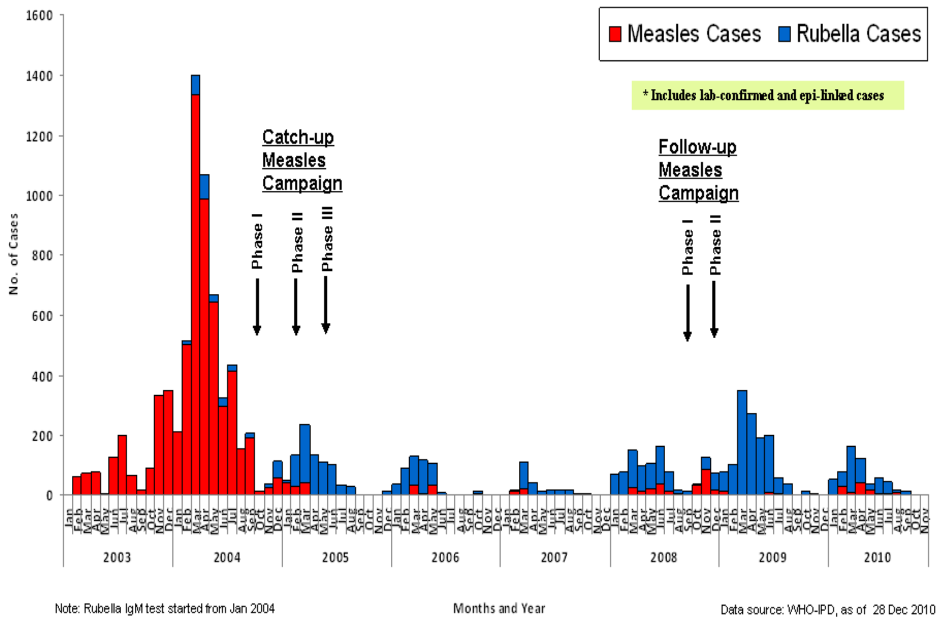
From 200 to 2008, all countries in SEARO except India and Thailand conducted nationwide measles catch-up campaigns that provided a second dose of measles vaccine. Supplementary immunization activites (SIAs) are very expensive and the authors encourage increasing routine immunization coverage for measles at least to 90% in all SEARO countries to provide a strong foundation for measles elimination.

2.4.4 *Measles and Rubella Surveillance*

2.4.4.1. Developing rubella vaccination policy in Nepal (Upreti et al., 2011).

This article describes the benefit of measles surveillance. Measles surveillance not only helped to reduce measles morbidity and mortality but also helped to uncover the burden of rubella in Nepal . The authors analyzed the surveillance data obtained from measles surveillance from 2004 to 2009. Nepal started measles surveillance in 2003 and from 2004 started testing measles and rubella IgM antibodies on blood serum. From 2004 to 2009, there were 3710 confirmed rubella cases. Among these total cases of rubella 95 % were less than 15 years of age. 1426 infants were born with congenital rubella syndrome (CRS) in 2008. In 2009 a rubella sero-prevalence cross sectional study was conducted at ten hospitals in Nepal, representing all five development regions of Nepal. Any women of child bearing age who attended the outpatient department of one of these hospitals from October through December, 2009, was eligible for enrollment. In all, 2248 women aged from 15 to 39 enrolled in the study. Blood specimens were taken from all of the enrolled women for immunoglobulin G (IgG) testing. Ninety percent (2020) were rubella positive. This proves that rubella transmission is ongoing in Nepal. These facts were also supported by lab based surveillance data for rubella IgM testing. On the basis of this study, the authors developed a rubella vaccination policy in Nepal. The existing measles surveillance network helped to pick up rubella as a health burden in Nepal as authors calculated 1,400 annual congenital rubella syndrome (CRS) case burden. CRS is a illness of infants born to women who had rubella infection during early pregnancy;

Fig-4 Rubella cases in Nepal after starting measles surveillance



2.4.4.2. Active Surveillance for CRS (Thant et al., 2006)

This article describes the process of active surveillance in hospital settings. This was the first population based study of CRS incidence in developing countries. In this study, the authors established hospital based active surveillance targeting children age 0 to 17 months with suspected CRS. They conducted this study from December 31, 2000 to December 31, 2002 in 15 hospitals of Yangon, Myanmar. They took blood samples for testing antibodies for immune- globulin G (IgG), IgM test and to detect rubella RNA using polymerase chain reaction (PCR). IgM positive proved that there was acute infection, IgG positive showed past infection with mother and PCR linked with rubella RNA for rubella virus. The study found incidence of 0.1 CRS in 1000 live births in Myanmar.

2.4.4.3. Measles case based surveillance lessons learned from China (Aiqiang et al., 2003)

This article reviewed the importance of measles case based active surveillance in China. The study was conducted in Sandong and Henan provinces of eastern China from 1999 to 2001. The case definition was a patient having fever more than 38 degree Celsius, generalized maculo popular rash and cough , fever, or coryza. All cases were to be reported, investigated and blood tested for IgM antibodies. In case based surveillance, the health worker had to visit hospitals every ten days. The result was compared with case based data and regular passive surveillance data. In a passive surveillance system, clinical suspected measles were reported. The results showed that active case based surveillance cases were higher than those identified through passive surveillance. In 2001, there 5772 suspected cases.

2.5. Summary of literature review

Literature review shows that measles routine immunization coverage should be strong for each country. This means every country should meet 90% measles routine coverage in order to reach for the measles elimination goal. If the measles coverage is less than 90% measles outbreaks can occur. The second most important thing found from this review is that measles supplementary immunization is very important to control measles outbreaks but SIAsbe implemented effectively and at the correct time. This means microplanning, logistic supply, supervision and monitoring should be in place during SIAs. The supplementary measles immunization coverage should be more than 95% in each round of the campaign to eliminate measles. Finally the review suggests measles case based surveillance is effective for measles diagnosis, and for detecting as well as managing measles outbreaks.   Findings from literature will help

SEARO countries to improve measles routine immunization, to improve measles SIAs and to enhance measles surveillance in future for measles elimination.

3. Methods

3.1. Selection of countries

The countries in this study are those in the SEARO region: Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri-Lanka, Thailand and East Timor (Figure 5)

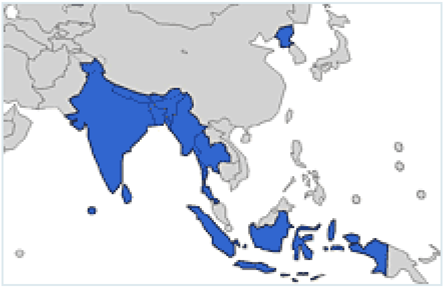


Figure 5. Countries in WHO Southeast Asia Region (SEARO)

3.2 Design

The study is an assessment of data on RI, Surveillance SIA from 1995 – 2012. It is a case study of all SEARO countries focusing on the research question outlined in Chapter 1. The vaccination strategies of selected countries are comparable to those recommended by WHO. To understand the vaccination system in these countries, elements vaccination system was gathered. The study questions were answered on the basis of literature review, WHO, SEAR countries measles datasets (measles trend analysis, incidence of measles cases/100,0000 inhabitants, MCV1 and MCV2 coverage rates, surveillance measles indicators), findings and information obtained from these countries.

3.3. Data analysis:

The data were entered in excel and Epi info, Open EPI and performed descriptive analysis of RI, SIA and measles incidence of SEARO countries.

3.4. Ethical Considerations

The data are unidentified and publically available from CDC and WHO, SEARO. Thus this study did not require IRB review.

4. Results

4.1. Measles routine Immunization services in SEARO

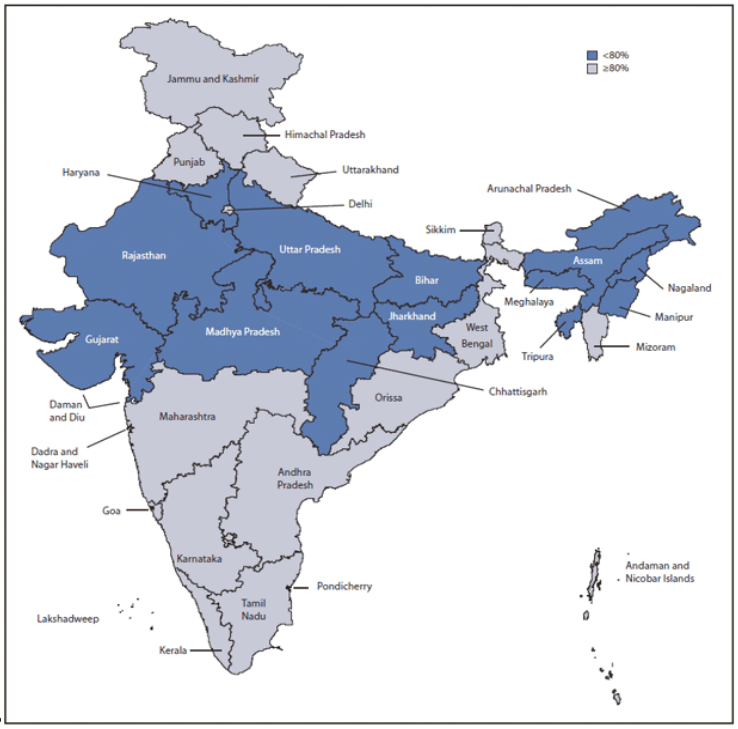
The Expanded program on Immunization (EPI) was initiated by WHO in May, 1974 (Keja, Chan, Hayden, & Henderson, 1988). The aim of this immunization program was to vaccinate children under one year of age with Bacillus Chalmette- Gurin (BCG), Diphtheria- Pertussis- Tetanus, Oral Polio Vaccine, and measles. According to the WHO routine immunization schedule measles vaccine is given at the age of 9 months. The maternal antibody protects for measles before the age of 9 months. Measles vaccine schedules of SEARO countries are different.

4.2.1. Current measles routine immunization services in India

India is the most populous country in SEARO region. There are 35 states and 655 districts in India. The state health department is fully responsible for routine immunization. The districts are the operational units for all routine immunization programs in India. The current population of India is 1.233 million, and the current birth cohort is 26 million. In India, under Universal Immunization Program (UIP) vaccines for six vaccine-preventable diseases (tuberculosis, diphtheria, pertussis, tetanus, poliomyelitis, and measles) are available free of cost to all. The first dose of measles is given at the age of 9 to 12 months and the second dose is given at the age of 16 to 24 months. In order to achieve the measles elimination goal by 2020, India has to achieve 90% measles routine immunization coverage. The most recent national survey coverage was conducted in 2009. According to this coverage survey the MCV1 coverage was 74% nationally. However, the coverage ranged from 48 to 96% at district level. According to WHO, SEARO MCV1 coverage in India remained constant at 74% in 2011 and 2012 as well. In 2013, at a WHO SEARO meeting India committed to improve routine immunization to achieve the goal of measles elimination.

Measles vaccine is available at central hospitals, medical colleges, district hospitals, taluk hospitals, primary health centers, nursing homes, clinics and outreach clinics in India. Primary health centers are the most basic units for services including routine immunization service. The measles vaccine, which the child receives subcutaneously, is a live vaccine and is very sensitive to heat. For long time storage it should be kept in minus 15-25 degrees Celsius. Measles vaccine is part of the integrated program of UIP in India. During a visit for the measles vaccine, a child will have the chance to receive other routine vaccines like polio, DPT and BCG if not immunized previously. In the private sector measles, mumps and rubella (MMR) vaccine is also available but this vaccine is very expensive and not free like the measles vaccine used in the UIP. Introducing MCV2 in routine immunization services varies from state to state. According to a UNICEF 2008 national evaluation survey, the routine immunization coverage for measles was <80% in 14 states and these same states started MCV2 in 2010 targeting children 9 months to 10 years through supplementary immunization activities. The remaining 21 states which achieved >80% measles routine immunization coverage, introduced MCV2 through the routine immunization system targeting children aged 16 to 24 months in 2010. The following map shows measles routine immunization coverage in 2008, in India (UNICEF, 2009).

Fig-6 Measles routine immunization coverage



2008

In this map, the deep blue shaded states are high risk of measles as the measles coverage is very low ranging from 46% to 77%. In these states, the Ministry of Health introduced a second dose of measles through campaign activities in 2010. The other 21 states where RI coverage is more than 80% (ranging from 80% to 96%) shaded light blue on the map, introduced MCV2 in routine immunization system targeting children 16 to 24 months.

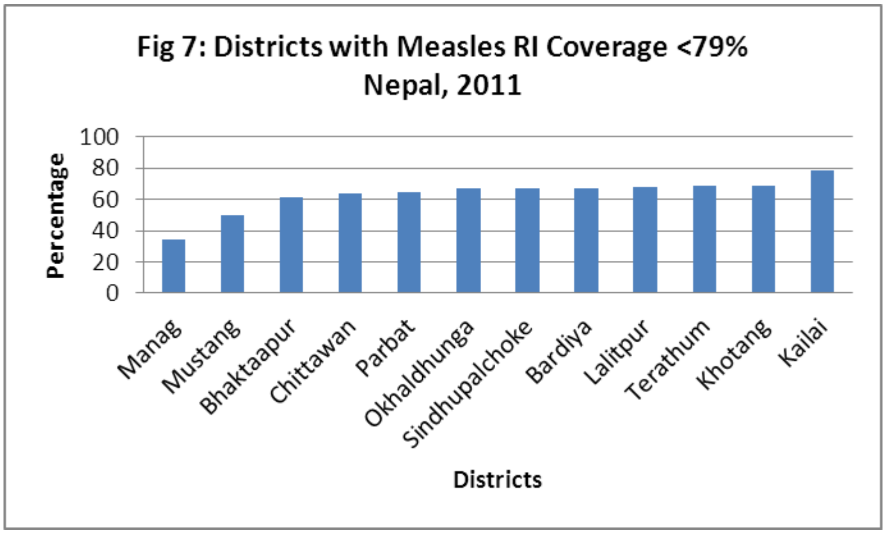
In this way , the government of India is trying to control measles by introducing MCV2 hrough routine immunization and through campaign activities. Currenty, for improving routine immunization, WHO is providing technical support and UNICEF is providing vaccine and logistic support for the Ministry of Health of India. The Bill and

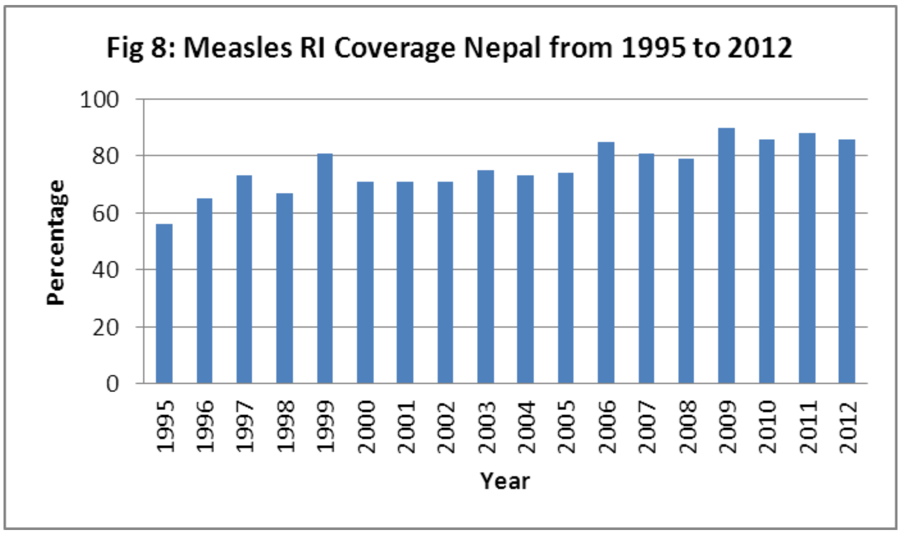
Melinda Gates Foundation and the Global Alliance for Vaccine and Immunization (GAVI) are also working to improve routine immunization in high risk states.

4.2.2. Measles routine immunization services in Nepal.

The national immunization program (NIP) is a high priority program of the government of Nepal. The current population of Nepal is 28 million and the birth cohort is 600,000 (GAVI, 2014). Nepal has 5 regions and 75 districts. NIP was started in 1988 with six antigens BCG, polio, diphtheria, tetanus, pertussis and measles. The first dose of measles is given at the age of 9 months. Routine immunization services are delivered through central hospitals, district hospitals, medical colleges, primary health centers, health posts and sub health posts, outreach clinics and mobile clinics. The district public health office is responsible for implementing the routine immunization program. The sub health post is the basic unit for providing routine immunization services at the village level. In urban areas, the urban health clinic provides routine immunization services. The village health workers (VHW) and maternal child health workers (MCHW) provide measles vaccination services at health post and sub health post levels and nurses, auxiliary health workers (AHW), and health assistants provide the services at health center, hospital and urban clinics. The routine immunization coverage in urban areas is 65% in part because the Ministry of Health is not responsible for providing immunization in urban areas. Rather the Ministry of Local Government is responsible for urban immunization in Nepal. The routine immunization coverage in 2011 was 86% at national level. The district level coverage ranged from 34% to 132% (MoHNepal, 2012). The routine measles coverage of districts is varied because it depends on climatic conditions. During the winter in mountaineous regions the immunization sessions are closed due to extreme cold . In 2009, coverage was 90% but declined from then until

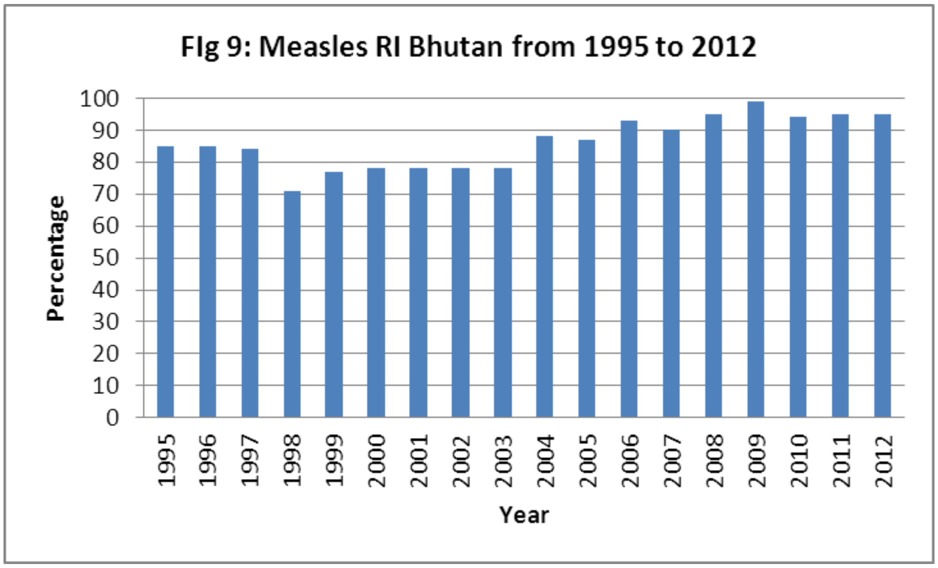
2012 although coverage remained above 85%. Measles coverage should be more than 90% at national level in order to meet the measles elimination criteria.





4.2.3 Measles routine immunization program in Bhutan

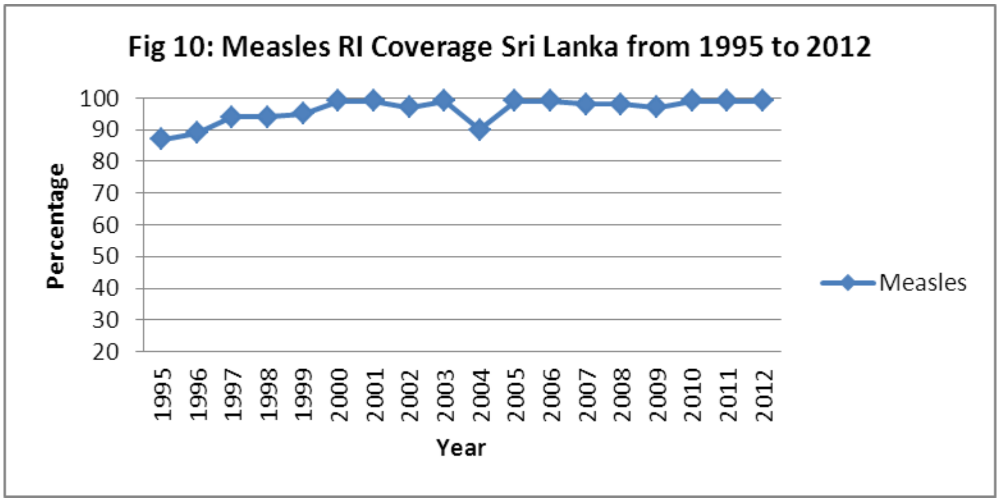
The EPI service started in 1979 in Bhutan with an objective of reducing six vaccine preventable diseases - tuberculosis, diphtheria, pertussis, tetanus, polio and measles. The current population of Bhutan is 725,296 and birth cohort for routine immunization is 14,300 (GAVI, 2014) . Currently, measles and rubella (MR) vaccine is used in the routine immunization program. Until 2005 monovalent measles vaccine was used but in 2006 the mono-valent was replaced by MR vaccine. The first dose of MR is given at the age of 9 months and the second dose is given at 24 months. Since 2005 Bhutan has maintained measles routine immunization coverage for both doses of more than 90% at national level.



This country has already met the measles elimination target. EPI is fully integrated in the general health system. Currently, the services are provided throughout the country in hospitals, Basic Health Units and outreach clinics. The Health Assistant (HA) , Auxullary Nurse Midwife (ANM) and Basic Health Worker (BHW) are responsible for providing immunization services to the children.

4.2.4. Measles routine immunization services in Sri Lanka

The current population of Sri Lanka is 20 million and the birth cohort for routine immunization is 370,000 (GAVI, 2013). The Ministry of Health Epidemiological Unit and the Family Health Bureau are jointly responsible for the implementation of the EPI. Immunizations are delivered through 8 provinces, 26 health districts and 285 health divisions (MoH, 2011) . The first dose of measles is given at the age of 12 months with MMR and second dose of measles is given at the age of 3 years. Since 1997 measles routine coverage has exceeded 95% at national level ranging from 80% to 99% at district level.

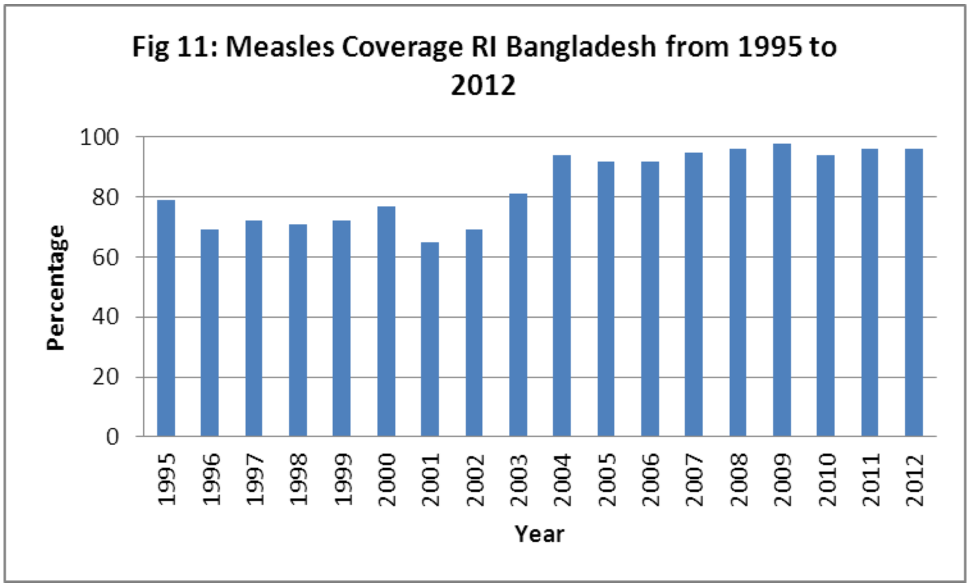


The recent measles coverage in 2012 and 2013 was 99%. Sri Lanka has already met the elimination goal by maintaining high measles routine immunization coverage. Based on this performance there is no need to conduct measles supplementary immunization activities. No measles outbreaks have occured since 2005. Sri Lanka maintains very strict immunization rules and regulations. There may be the chance of measles outbreaks in Sri Lanka at any time in children from 6 months to 12 months of age because of the late measles vaccination schedule. In other SEARO countries measles vaccine is given at the age of 9 months.

4.2.5. Measles routine immunization services in Bangladesh.

According to the 2013 WHO report the total population of Bangladesh is 155 million and birth cohort for immunization program is 3 million. The EPI program was started in 1979 but it was fully implemented only in 1985. In 1995 the MCV1 coverage was 78%

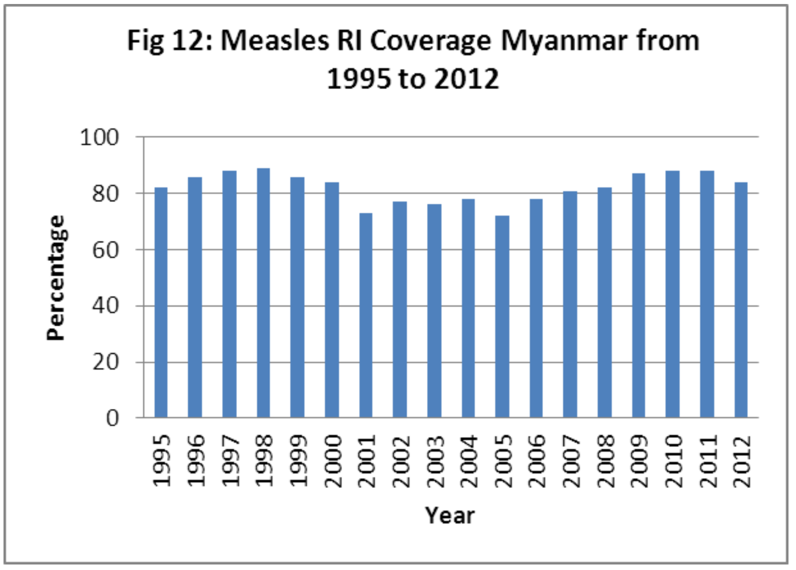
only which rose significantly to 96% at national level in 2012.



The national immunization program is integrated with primary health care services (USAID, 2011). Immunization services at rural level are provided through district hospitals, upazilla fixed posts, and EPI outreach sites. Immunization services in urban areas are provided through urban hospitals and urban health centers. The first measles vaccine is given at the age of 36 weeks with rubella and the second dose is given at the age of 18 months with single measles. For females a third dose is given at the age of 15 years with MR. Since 2005 Bangladesh has sustained high, greater than 95%, routine immunization coverage. The required target is 90 percent or more for measles elimination by 2020. This means that Bangladesh is on course for measles elimination using routine immunization strategies.

4.2.6. Measles routine immunization services in Myanmar

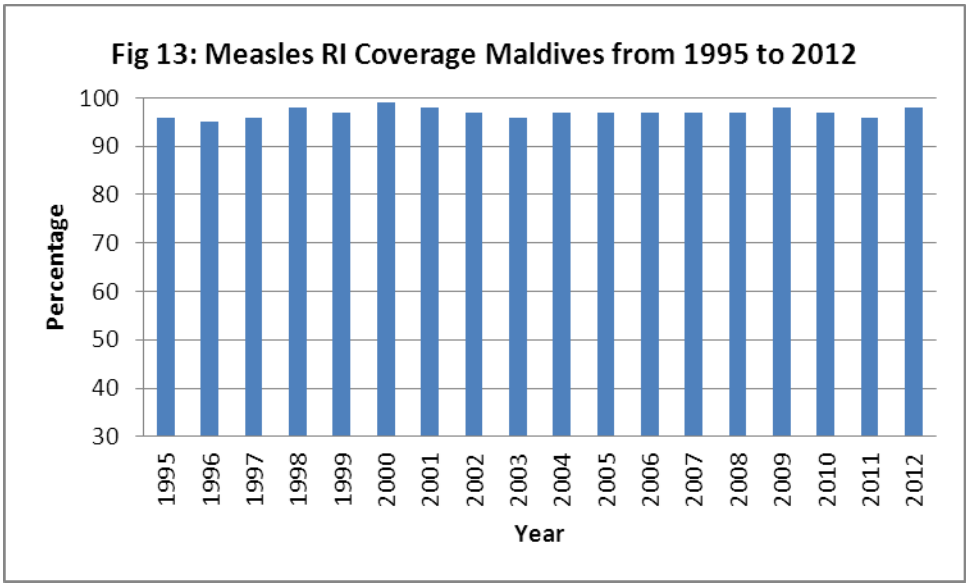
The current population of Myanmar is 61 million and the target population for routine immunization is 1.5 million (Myanmar, 2012) . The EPI program was launched in Myanmar in 1978 but measles vaccine was introduced only in 1987 into the EPI program. Immunization services are provided by maternal and child health clinics at urban and township hospitals and rural health centers and outreach clinics in rural areas. The health assistant, nurses, and auxiliary health workers are the staff for measles immunization program. The first dose is given at the age of 9 months and the second dose at the age of 18 months. The most recent (2012) measles coverage is 84% at national level. In 1995, the measles the coverage was 82%. Until 2005 the coverage remained between 70 to 80% but after 2005 to 2012 the routine measles coverage improved and stayed between 80 to 86%.



It is encouring that coverage has increased but it is not yet high enough to achieve elimination. . Myanmar has committed to increase routine immunization and to reduce child mortality by 95% by the end of 2015. The WHO, GAVI and UNICEF are helping the Ministry of Health in Myanmar to improve measles routine immunization program and surveillance activities. The WHO is providing technical assistance at country and provincial level for improving measles surveillance; UNICEF is providing logistic support for measles supplementary activities and routine immunization and the GAVI is funding immunization training for health staff at provincial level.

4.2.7. Measles routine immunization services in Maldives

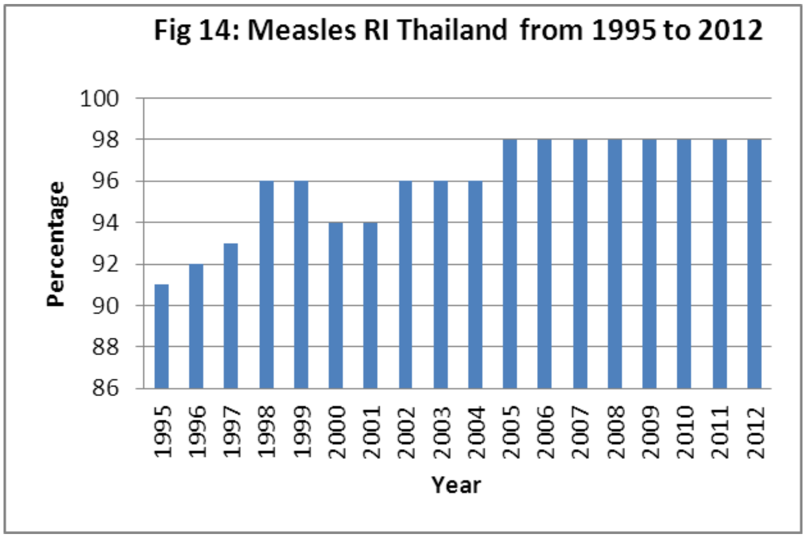
According to GAVI, 2013, the population of Maldives is 393,988 and the birth cohort for immunization is 7500. Maldives is the smallest country in SEARO region. Immunization services are provided through central hospitals, atoll hospitals, health center and health post. The first dose of measles is given at 9 months and second dose is given in the form of MMR at 18 months of age. The incidence of measles in this country is zero and vaccination coverage was 99% in 2012 and 2013. Since 2005 the measles vaccination coverage has been sustained above 95%. Maldives has met the measles elimination target since 2007.



4.2.8. Measles Routine immunization services in Thailand

The current population of Thailand is about 69.5 million and the target population for routine immunization for measles is 2.7 million. The national expanded program on immunization was initiated on a national basis in 1977 focusing on immunization for tuberculosis, diphtheria, pertussis, tetanus, polio, and measles. The immunization delivery system is provided through hospitals and health centers in Thailand. The first dose of measles is given with MMR at the age of 9 months and second dose is given at the age of 7 years with MMR. In 1985 the measles coverage was 26 % and rose up to 98% in 2012. Since 1999 the measles coverage has remained

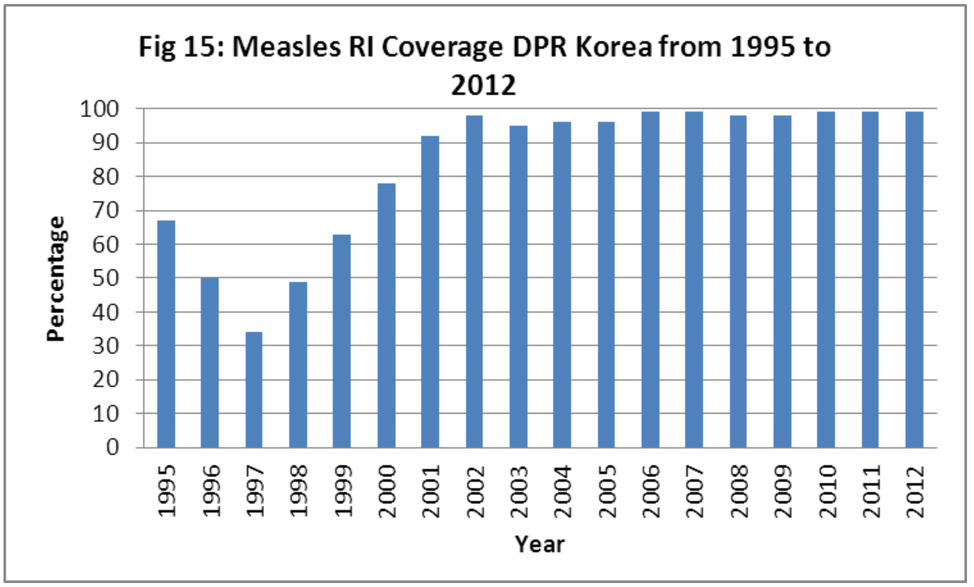
above 95%.



Despite the high routine immunization coverage, the incidence of measles is very high. In 2012 there were 5197 reported measles cases in Thailand. The long gap between the two required measles doses among the targeted group causes the frequent outbreaks of measles in Thailand.

4.2.9. Measles routine immunization services in Democratic People's Republic of Korea (DPRK)

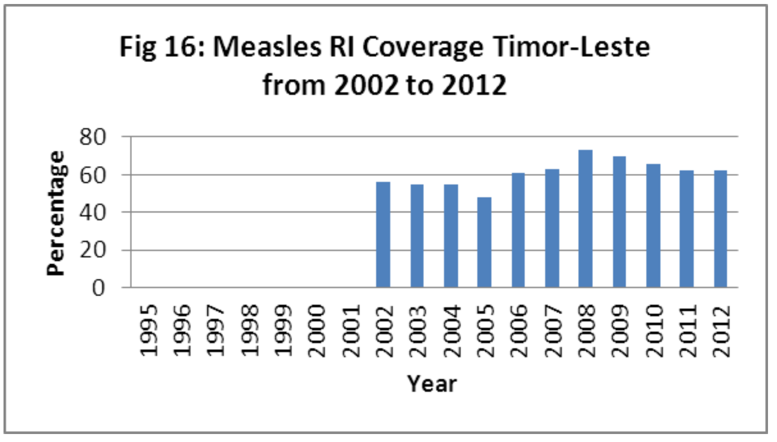
The total population of DPRK is 24 million and the total birth cohort for the routine immunization is 350,000 (DPRK, 2011). The routine immunization for measles began in 1980 with the national EPI program. The routine immunization services are delivered through hospitals, health centers and polyclinics. The first dose of measles is scheduled at 9 months with single antigen and the second dose is given at 15 months. In 1995, the measles coverage was 67% and it rose gradually to 92% in 2001, progress interrupted from 1996 to 1999. From 2001 to date coverage is above 95%. The recent coverage in 2012 was 99% at national level.



This country has met the measles elimination criteria in terms of measles routine immunization which must be more than 90% at national level The incidence of measles must be less than 5 per million population but DPRK country has zero measles cases since 2007.

4.2.10. Measles routine immunization services in Timor-Leste

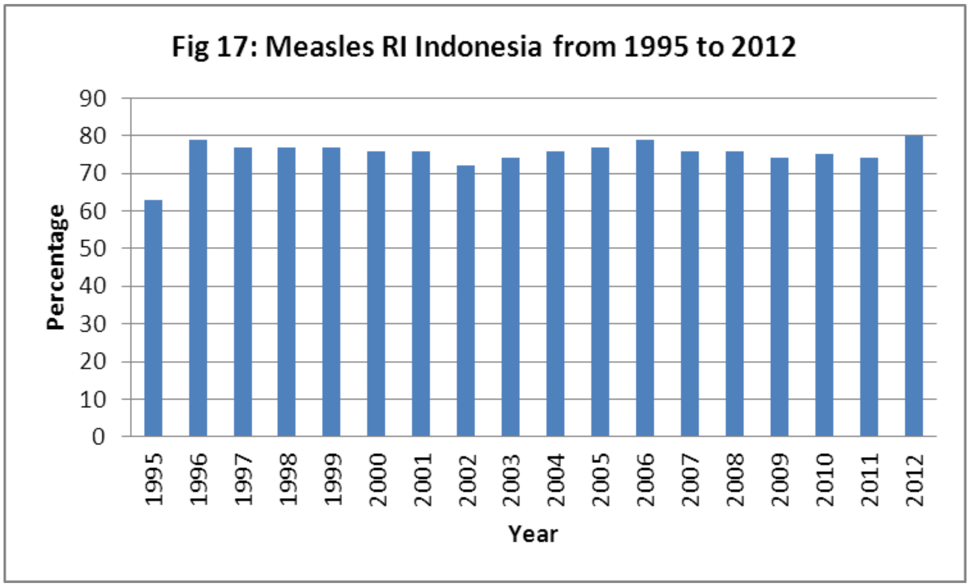
The current population of Timor-Leste is one million and the birth cohort for routine immunization program is 40,000 children. The measles immunization services are provided only through community health centers and health posts. This country received independence in 2002 from Indonesia. All health related activities started from the year 2002 only. The measles vaccine is scheduled at the age of 9 month with single antigen of measles. The reported coverage of MCV1 in 2002 was 56 % and the most recent coverage in 2012 was 62%. . Not only is measles coverage low but coverage rates for other antigens also remained below 70% until 2012. Due to sparse population in mountainous regions and inadequate health infrastructure this country faces grave challenges to improve routine immunization. With current measles immunization coverage Timor-Leste is far behind for measles elimination by 2020. The universal measles coverage must be 80% at district level and 90% or more at national level but this country is achieving 62% measles coverage only.



In 2011 there were large out-breaks in Dili and Ermera districts. A total of 739 cases was reported from these measles outbreaks. There were 8 measles associated deaths from this outbreak. In 2011, the measles incidence was 711 per million but for elimination it must be less than 5 cases per million. The WHO, UNICEF and GAVI are assisting the Ministry of Health to improve measles routine immunizationin Timor-Leste.

4.2.11 Measles routine immunization services in Indonesia

Indonesia is the home of 249 million people. The target population for routine immunization is 4 million. Expanded program on immunization started in 1977 in Indonesia. Immunization services are provided through hospitals, health centers and fixed and mobile clinics. In Indonesia, the first dose of measles is given at the age of 9 months and second dose is scheduled at the age of 6 years. In 1995 the measles routine coverage was 63% rising to 80% in 2012. From 1999 to 2011 measles coverage remained between 66 and 76%.



At this coverage Indonesia is still far behind to achieve the measles elimination goal by 2020. Low routine immunization coverage and the late vaccine schedule for the second dose are the main cause of measles outbreaks and deaths in Indonesia. In 2010, 5% of measles deaths occurred in children under five years of age. In 2013, huge outbreaks were reported from Bali and 6300 cases were reported from this outbreak (CDC, 2013). The international community was affected by this outbreak as US travelers got measles from Bali and transmitted measles in Texas.

5. Current measles surveillance system in SEARO countriesSurveillance is the ongoing, systematic collection, analysis, interpretation and dissemination of health related data essential to planning, implementation, and evaluation of public health practice (WHO, 2011).

Currently, three types of surveillance systems are used in SEARO countries for measles reporting and investigation. The first one is national passive surveillance which involves passive notification through regular reporting of diseases data by all facilities that see patients or test specimens.

A passive surveillance system is the most common method used by SEARO countries to detect measles, the least expensive, and covers the wide range of geographical areas. India and Thailand use this surveillance system.

Another surveillance type is active surveillance which involves visiting health facilities, talking to health staff and reviewing medical records to identity suspected cases of the disease under surveillance. This type of surveillance is used in Nepal, Bangladesh, Myanmar and Indonesia through WHO supported surveillance networks. The third strategy is sentinel surveillance which includes limited number of carefully selected reporting sites with high burden of cases, good laboratory facilities, and qualified staff. This type of surveillance is used in Nepal, India , Myanmar, Bangladesh and Indonesia. The last type of surveillance is measles case based surveillance. It is the collection of the key demographic and epidemiological information on every person that meets the clinical case definition. Measles case based surveillance also covers outbreak surveillance.

All countries in, SEARO that are targeting measles elimination should investigate every suspected case as part of the cased based surveillance with laboratory specimens collected within 28 days of rash onset from every person. However, India is implementing case based surveillance in 8 states only. The strategy for conducting measles case based surveillance is that countries who completed measles supplementary immunization campaign have to start case based surveillance after completion of the SIA campaign. For elimination measles case based surveillance system in a country is mandatory.

Measles surveillance in SEARO countries has two components for elimination. The first one is routine surveillance which covers monthly and weekly reporting or zero reporting which indicates no measles cases during the reporting period. Another one is outbreak case based surveillance which covers the line list of all measles reported during outbreaks. The line list starts with a patient identification number, onset of rash, clinical signs and symptoms, complete address of the patient, lab specimens and results. Serologic testing of samples from at least 5 suspected case patients per outbreak for measles IgM antibodies are required under outbreak surveillance. The following table shows the countries investigating outbreaks and conducting IgM testing in SEARO countries.

Fig 18: Type of surveillance and serological testing in SEARO countries

Countries	**Type of surveillance**	**Serological Testing**
India	Case based in 7 states and aggregate in 28 states	Only in 7 states
Nepal	Case based	All outbreaks
Myanmar	Case based	All outbreaks
Indonesia	Case based	All outbreaks
Timor-Leste	Case based	All outbreaks
Thailand	Case based	All outbreaks
Maldives	Cases based	All outbreaks
Sri-Lanka	Case bases	All outbreaks
Bangladesh	Case based	All outbreaks

DPR Korea	Case based	All outbreaks
Bhutan	Case based	All outbreaks

According to this table India is the only SEARO country collecting data through aggregate data and not investing all outbreaks; outbreaks are investgated only in 7 states: Andhra Pradesh, Gujarat, Karnataka, Kerala, Rajasthan, Tamil Nadu, and West Benga. In these states measles incidence rate is high, 70 cases per million population. India is far behind other SEARO countries for conducting cased base surveillance to meet the goal of elimination. However, the government of India is committed to establishing a case based surveillance networks through existing polio surveillance system.

6. Performance of measles and rubella supplementary activities in SEARO 1995 to 2012

To meet the elimination criteria by 2020 each country in the SEARO region has to achieve measles RI coverage of 90% or over at national level and 80% or more at district levels. The second criterion is that supplementary measles campaign coverage should be more than 95% to interrupt the measles virus. The third criterion is that each country has to establish case based lab surveillance networks and all measles outbreaks have to fully investigated, specimen tested for IgM antibodies and classified with lab results. The final criteria is each country should maintain measles incidence of 5 or less per million of population.

6.1. Measles supplementary immunization in India

The first catch up campaign was conducted in 2010 in 7 states of India where the measles routine coverage was less than 80%. The target age group for the catch up campaign was

9 months to 10 years of age. This campaign was conducted in phases. The first phase targeted 7 states of India and the coverage was 89%. This phase wise campaign was extended in 2011 to 5 more states of India and the coverage was 83%. In 2012, the catch up campaign was targeted for 2 states and coverage was 73%.

This SIA coverage is still below the 95%. It means there is the chance of circulating measles virus continuously. In addition, the RI coverage is also less than 70% in some states. With these conditions, the number of susceptible children will be more and more. Three indicators of elimination are below standard and indicate the possibility that measles outbreaks in future will occur. However, the government of India is committed to improve RI and SIA coverage.

6.2. Supplementary immunization in Nepal

Nepal started measles catch up campaign in 2004 targeting children from 9 months to 15 years of age. The campaign was conducted in phase wise manner in 2004 and 2005 and covered all 75 districts. The campaign coverage was more than 100% for both phases. In 2008, another follow up campaign targeting 9 months to 5 years of age was conducted and coverage was 94% only. In 2012, measles and rubella (MR) catch up campaign was conducted at sub national and coverage was 94%.

From this campaign results Nepal performed just below the standard of 95% in 2008 and 2012 rounds of SIA campaigns. Coverage is not optimal due to fear of measles vaccine and denominator problem in urban areas due to migration from village to city areas. In addition, internal conflicts also hampered the measles campaign in the year 2008 and 2012.

6.3. SIAs in Myanmar

The follow up SIA was conducted in Myanmar in 2002, 2003, and in 2004 in a phase wise manner. The target group for these follow up campaigns was children 9 months to 5 years. The campaign coverage was 85%. In 2007, a nationwide follow up campaign was again conducted targeting 9 months to 5 years of age children. The coverage was 94% and in 2012 the another follow up campaign was conducted targeting 9 months to 5 years of children and the coverage was 97%.

Coverage in Myanmar is improving gradually. It was 85% in 2002 campaign and reached up to 97% in 2012 campaign.

6.4. SIAs in Bangladesh

Bangladesh conducted its first catch up campaign in 2005 and in 2006 targeting children 9 months to 10 years in phases .The coverage in the first phase was 93% and second was 101%. The follow up campaign was conducted in phasesin 2010 at national level targeting children 9 month to 59 months. The coverage was 93% for first phase and 100% in second phase.

The campaign coverage reached more than 95% at each round and met the elimination criteria. However, in coming years the coverage should be maintained at this level. Micro- planning and awareness programs were very effective in Bangladesh in increasing and sustaining coverage SIA coverage.

6.5 SIAs in Indonesia

Indonesia has conducted 2 rounds mop up, 10 rounds catch up and 8 rounds follow up campaign between 2000 to 2011. Coverage in most of the campaign rounds was below 95% and only 4 rounds campaign met the criteria for elimination.

6.6. SIAs in Maldives

Maldives conducted 2 catch up rounds of MR and one round of MMR campaigns from 2005 to 2007. The campaign coverage rates are below 80%. However, RI measles is 99% in this country. After the SIA campaign the incidence of measles was zero as of 2012. While SIA coverage rates are below the standard, a strong routine immunization program has seen the measles incidence is go down. The incidence of measles in Maldives is zero per million in 2012.

6.8. SIA In other SEARO countries

Bhutan, and Sri Lanka and DPR Korea maintained more than 95% coverage and these countries have met the elimination target. But each must sustain the high level of coverage in order to achieve the 2020 elimination goal. Timor-Leste could not keep the campaign coverage above 80%. In the SEARO region, India, Indonesia, Timor-Leste, Myanmar and Nepal are behind in routine immunization and n campaign coverage. India is the only SEARO country that does not have a case based surveillance system.

7. Discussion and Recommendations

7.1. Linkage between measles surveillance and rubella.

This study helps to link the benefit of measles surveillance for other vaccine preventable disease surveillance like rubella. The incidence of rubella in Myanmar, Maldives, Srilanka, Bhutan, DPR Korea is ess than 5 per million population while India, Nepal, Bangladesh, Thailand still have more than 25 cases per million. With the help of measles surveillance many SEARO countries have found that rubella is a public health burden of disease. Rubella looks like measles and the clinical presentations are also similar to measles but it can cause congenital rubella syndrome (CRS), a significant cause of disability. Rubella itself is less risky for the child in terms of having complications but when the virus is transmitted to susceptible pregnant women , the child is at risk of acquiring congenital rubella syndrome.

In Nepal, measles surveillance was integrated with acute flaccid paralysis surveillance networks in 2003. After 2004, samples obtained from the outbreaks for measles were tested for rubella IgM antibodies and showed many cases of rubella. From 2004 to 2009 there 2710 reported fever with rash cases. 95% of the cases were positive for rubella. During this same time, due to the good effect of measles routine immunization and a series of catch up and follow up campaigns from 2004 to 2008, the incidence of measles went down, but the incidence of rubella went up. The rubella sero-survey study in 2009 estimated an annual CRS disease burden of 1400 cases. This study was possible due to measles surveillance. This suggests that good measles surveillance helps to enhance rubella and CRS surveillance in SEARO countries. Other SEARO countries also reported rubella after establishing measles surveillance networks. Bangladesh, India, Nepal, reported the highest number of rubella cases among the

SEARO countries from 2004 to 2012. There were 1025 rubella cases in India in 2012, in Nepal 801 were reported, in Indonesia 2020 and in Bangladesh 3245 cases were reported in 2012. Countries introducing MR and MMR vaccine in their routine immunization program reported few cases of rubella from the period of 1999 to 2012. These facts support the claim that measles surveillance definitely benefits the rubella and CRS surveillance and provides the impetus for introducing MR vaccine in all countries of SEARO.

7.2. Linkage between measles case based surveillance and measles elimination

Measles case based surveillance is the key strategy to eliminate measles. All SEARO countries except India have successfully introduced the measles case based surveillance. Case based surveillance is a lab based surveillance method which helps to diagnose the measles or rubella or non-measles cases. The policy for implementing the measles case based surveillance is to introduce measles second dose through routine immunization or through campaign activities. Nepal, Myanmar, some states of India, Indonesia, DPR Korea, Timor-Leste and Bangladesh implented case based surveillance after campaigns. Bhutan, Maldives, Thailand, and Sri Lanka introduced case based surveillance after implementing the second dose of measles in the form of MR or MMR. After establishing measles case based surveillance many countries reported confirmed measles outbreaks from measles or rubella. It helped health care providers as well as public health managers to implement programs for controlling outbreaks and to find the burden of disease for future vaccination programs. In SEARO countries case based surveillance for measles improved gradually.

Countries in the Americas eliminated measles in 2002 and measles case based surveillance was the effective strategy for measles elimination. China conducted research in 2000 on active case based surveillance and found more cases are reported through this surveillance system and they detected many outbreaks of measles through this system. There are fewer chances of missing cases using the case base surveillance system. All clinical suspected cases are reported and tested for measles. China implemented case based surveillance for measles elimination throughout the country from 2003. Moreover, case based surveillance detected rubella case from lab testing.

Nepal is another good example of case based surveillance. Nepal started case based surveillance in 2007 with 15 hospitals in the Kathmandu Valley. By the end of 2010 these units expanded up to 89 sites for case based surveillance throughout the country. From all these sites, measles like cases were reported and tested for IgM for measles and rubella. In 2010, there were 33 measles like outbreaks throughout the country. Among these, 9 outbreaks were associated with measles, 19 out-breaks were associated with rubella and 2 outbreaks were mixed with rubella and measles and the remaining 3 outbreaks were neither from measles or rubella and were discarded. All 9 measles outbreaks were fully investigated by a district rapid response team. Nepal is benefiting from case based surveillance to reduce measles morbidity. Case based surveillance also helped to identify that rubella was another big problem in Nepal. A sero-surveillance study in 2009 showed rubella was endemic in Nepal and recommended the use of the measles rubella vaccine. Nepal conducted mass a mass measles and rubella campaign in 2012 at national level targeting children 9 months to 15 years of age. It was a great achievement for Nepal to introduce measles and rubella vaccine in the country.

Case based surveillance is highly effective in Nepal and Bangladesh but this type of surveillance system is very expensive for developing countries. WHO qualified lab networks are based at the central level only. It's very difficult to transport lab specimens from remote places to the central level. Samples for polio are tested only in Thialand so the lab network is not yet developed in Nepal as WHO standard for polio surveillance. The districts of remote areas face problems in blood specimen shipment and transportation to central lab and results are often delayed thus making planning difficult at district public health offices. Laboratory network expansion needs more trained staff, logistic materials and availability of testing kits. National governments have to take responsibility with assistance from other agencies like WHO and UNICEF until measles elimination is achieved.

7.3. Linkage between measles supplementary immunization and measles epidemic.

Measles supplementary immunization will help to reduce measles epidemics. Measles supplementary immunization campaigns were conducted from 2000 to 2012 at three to four year intervals in SEARO countries. After analyzing the data supplementary versus reported measles cases provide clear evidence that after measles supplementary campaigns, measles cases decreased for aperiod of two to three years. In countries where measles immunization coverage is very high, measles SIAs helped to decrease measles incidence dramatically. The evidence from Maldives proves this statement. The routine immunization coverage in Maldives has been above 95% for over ten years. Despite having high immunization coverage Maldives reported 1395 measles cases in 2005. The government of Maldives decided to conduct a catch up MR campaign in 2005 targeting population 6 years to 34 years and mop up campaign in 2006 targeting population from 6 years to 35 years of age and MMR catch up campaigns targeting children 4 to 6 years of age. After these campaign activities measles cases decreased. In 2006, the Maldives reported 47 cases and in 2009 only 6 cases of measles were reported. This highlights that measles supplementary activities helped to decrease measles epidemics.

Evidence from Nepal proves that the SIAs helped to reduce measles epidemics for the two to three years where the routine immunization coverage for measles was less than 90% at national level. Before 2005 Nepal did not have measles campaign but in 2004 and 2005, the country conducted measles SIAs in phase wise manner. During 2005, 5023 measles cases were reported and in 2006 there were 2838 measles cases reported. More than 80% of these cases were below 15 years of age. The routine immunization coverage in 2005 and 2006 was below 80% at district level. Given these data , Nepal decided to conduct a catch up campaign targeting 9 months to 15 years of age population. The campaign coverage was more than 100%. After these campaign activities incidence of measles was reduced by 75% in 2007. The total number of measles reported cases in 2007 was 1417. But again in 2008 measles cases went up due to measles outbreaks. In these reported cases most of the affected children were below 5 years of age. Again, the government of Nepal decided to conduct a follow up campaign to respond to these epidemics. The campaign coverage for this round was 93%. After this campaign measles incidence went down to 189 cases in 2009 and 190 in 2010. However, from 2010 measles cases increased and in 2011 there were 2359 measles cases reported where as in 2012 were 3362.

The evidence from Maldives and Nepal illustrates that a measles campaign definitely helps to control the measles epidemics in low and high routine coverage settings.

7.2. Strength of the study

This study analyzed SEARO data on measles from 1995 to 2012 and found that measles surveillance also provides surveillance for rubella and helps to highlight an unidentified burden of disease from rubella. . Another strength highlighted by the analysis was confirmation that case based surveillance is the best method for measles surveillance. Lastly , our analysis shows that measles SIAs help to reduce measles epidemics in low and high routine coverage settings.

7.3. Weakness of the study

The study is based on data reported to SEARO . While there is no documented reason for countries to report higher than actual coverage or lower than actual cases of measles, there may be some incentives to inflate figures for political purposes. Another weakness is that this study is purely descriptive; available data did not allow for epidemiological modelling.

7.4. Recommendations

7.4.1. Recommendation for improving measles routine immunization activities

- Microplanning at village level helps to identify current population denominators, households, ethnic groups, migrant populations and required budgets, sessions, and logistic requirements. During micro planning local authority should be invoved in all steps of the process.

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- Community based health education is required to improve routine immunization. Measles is given through injection. It is not like polio oral drops. Many children and parents feel fear measles injection. Health education at community level will help to eliminate the stigma of the community and the vaccine acceptance rate will increase.

- Every country should have the the immunization laws and regulations like those in Sri Lanka, DPR Korea, and Bhutan. These countries are maintaining high measles routine immunization coverage. In these countries, immunization law rules are very strict in rewuirements for school admission. Follow up on an adverse event from immunization is also very strong. If anything happens after immunization the government has strict laws in place. Other countries like Nepal, Bangladesh, and India are facing challenges to manage events after immunizations because they have not passed adequate enforcement requirements for adverse events following immunization.

7.5. Recommendation for supplementary measles campaign

- Enhance campaign awareness at national, district and community level by providing information in the appropriate ethnic language.
- Coordinate education and training between different medical professional organizations like medical association, pediatric association, and nursing association.

For each supplementary campaign it is necessary to sensitize the broad public, the community, politicians, different medical and nursing professional organizations. Better coordination will enable better monitoring of logistics and implementation of campaigns. Countries like Indonesia and Thailand have a long gap in measles routine immunization between from first dose to second dose. In both countries first dose of measles is given at 9 months of age and second dose is given at the age of 6 years in Indonesia and at 7 years in Thailand. This long 6 year gap between first dose and second provides the chance of getting measles as in measles only 85% of children will develop immunity. These two countries should reduce the gap between the two doses to reduce the incidence of measles.

7.6. Recommendation for measles surveillance activities:

- Expand the measles laboratory network from national level to regional level in each country. This will require external financial aid.
- An electronic surveillance system should be established in each country of SEARO. America is the only country in the world using electronic surveillance for surveillance activities. With the help of this electronic surveillance activities measles and rubella have been eliminated from America.

Conclusions

SEARO countries definitely can eliminate measles by 2020. However, countries like Nepal, Myanmar, Indonesia and India still have universal routine immunization coverage below 80% at district level (ranging from 46% to 96%). These countries have to accelerate efforts to increase routine immunization. Once the routine immunization is strong , supplementary campaigns will help to maintain high levels of community immunity.

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