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ABSTRACT

The 1st Workshop on National Immunization Programs and Vaccine Coverage in Association of Southeast Asian Nations (ASEAN) Countries Group (WNIPVC-ASEAN) held a meeting on April 30, 2015, Pattaya, Thailand under the auspices of the Pediatric Infectious Diseases Society and the World Health Organization (WHO). Reports on the current status and initiatives of the national immunization program (NIP) in each ASEAN countries that attended were presented. These reports along with survey data collected from ministries of health in ASEAN countries NIPs demonstrate that good progress has been made toward the goal of the Global Vaccine Action Plan (GVAP). However, some ASEAN countries have fragile health care systems that still have insufficient vaccine coverage of some basic EPI antigens. Most ASEAN countries still do not have national coverage of some new and underused vaccines, and raising funds for the expansion of NIPs is challenging. Also, there is insufficient research into disease burden of vaccine preventable diseases and surveillance. Health care workers must advocate NIPs to government policy makers and other stakeholders as well as improve research and surveillance to achieve the goals of the GVAP.

1. Introduction

The 1st Workshop on National Immunization Programs and Vaccine Coverage in Association of Southeast Asian Nations (ASEAN) Countries Group (WNIPVC-ASEAN) held a meeting on the 30 April, 2015 in Pattaya, Thailand to promote knowledge sharing and collaboration amongst ASEAN countries. Delegates with leadership roles in national immunization programs (NIP) from ASEAN countries including Brunei Darussalam, Cambodia, Indonesia, People's Democratic Republic of Laos (Laos PDR), Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam participated. The workshop was convened by the Pediatric Infectious Disease Society of Thailand on its 19th Annual Meeting celebrating the 20th anniversary of the society.

The scientific program of the workshop included presentations and discussions about NIPs and vaccine coverage from delegates of attending ASEAN countries. The workshop was chaired by Dr JM Okwo-Bele, the Director of the World Health Organization (WHO) Department of Immunization, Vaccines and Biologicals, and was moderated by Dr Tawee Chotpitayasunondh (Thailand) and Dr Tikki Pangestu (Singapore).

This paper reports on the current NIPs, vaccination coverage, NIP challenges and the discussed future recommendations for the various ASEAN countries.

2. Demographic characteristics of the ASEAN region

The ASEAN region has a population of around 616 million people, of whom 9.1% are aged 0–4 years and 27.2% are aged 5–19 [1]. The 10 countries include Brunei Darussalam, Cambodia, Indonesia, Laos PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. These countries vary greatly in physical and human geography. For example, Indonesia has the largest land area in the region of around 1860,000 sq km compared with 716 sq km in Singapore [1]. Indicators of health also vary greatly. The under-5 mortality rate (per 1000 live births) for 2013 in Myanmar was 51 compared to 3 in Singapore, and the infant mortality rate (per 1000 live births) for 2013 in Laos PDR was 54 compared to 2 in Singapore [2]. The countries of the region are divided between two WHO regions, namely the South East Asian Region and the Western Pacific Region. Issues of physical and human geographical diversity make unique challenges for NIPs of ASEAN countries.

3. National immunization programs in ASEAN countries

Table 1 summarizes the NIPs of ASEAN region countries in 2015.

Abbreviations: ASEAN, Association of Southeast Asian Nations; WNIPVC-ASEAN, 1st Workshop on National Immunization Programs and Vaccine Coverage in Association of Southeast Asian Nations Countries Group; NIP, national immunization program; WHO, World Health Organization; EPI, Expanded Program on Immunization; BCG, Bacillus Calmette–Guérin; DTP, diphtheria–tetanus–pertussis; Hib, *Haemophilus influenzae* type b; MR, measles–rubella; SIA, supplemental immunization activities; JE, Japanese encephalitis; RV, rotavirus vaccine; PCV, pneumococcal conjugate vaccine; HPV, human papillomavirus vaccine; Gavi, Global Vaccine Alliance; GVAP, Global Vaccine Action Plan; AEFI, adverse events following immunization; WHA, World Health Assembly; IPV, inactivated poliovirus vaccine; OPV, oral polio vaccine; MBJEV, mouse brain-derived Japanese encephalitis vaccine; DTP3, three doses of DTP JE vaccines; MNT, maternal neonatal tetanus; VPD, vaccine preventable diseases; UNICEF, United Nations Children's Fund.

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Table 1
National immunization programs of the 10 ASEAN countries.

	BCG	HBV	DTP	Polio	Hib	Measles	Rubella	JE	Rotavirus	PCV	HPV
Brunei Darussalam	√	√	√	√	√	√	√				√[a]
Cambodia	√	√	√	√	√	√	√			√	
Indonesia	√	√	√	√	√	√					
Laos PDR	√	√	√	√	√	√	√	√[b]		√	√
Malaysia	√	√	√	√	√	√	√	√[b]			√[c]
Myanmar	√	√	√	√	√	√	√[d]				
Philippines	√	√	√	√	√	√	√		√[b]	√	
Singapore	√	√	√	√	√	√	√			√	√[e]
Thailand	√	√	√	√		√	√	√			
Vietnam	√	√	√	√	√	√	√[f]	√[b]			

Abbreviations: BCG, Bacille Calmette Guérin vaccine; HBV, hepatitis B vaccine; DTP, diphtheria–tetanus–pertussis vaccine; Polio, poliomyelitis vaccine; Hib, *Haemophilus influenza* type b vaccine; JE, Japanese encephalitis vaccine; PCV, pneumococcal conjugate vaccine; HPV, human papillomavirus vaccine *Source:* WHO vaccine-preventable diseases: monitoring system. 2015 global summary. Available at: http://apps.who.int/immunization_monitoring/globalsummary/schedules?sc%5Br%5D%5B%5D=SEARO&sc%5Bd%5D=&sc%5BOK%5D=.

[a] School girls aged 13 years: 3 doses at 0, 1 and 6 months.
[b] Subnational use.
[c] Female aged 13 years: 3 doses at 0, 1 and 6 months.
[d] MR catch-up campaign followed by national routine use May, 2015.
[e] Females aged 9 to 26 years: 3 doses at 0, 2 and 6 months.
[f] MR campaign from Sep 2014, followed by national routine use from June 2015 for children from 18 month of age.

3.1. The six basic Expanded Program on Immunization antigens

All ASEAN countries have scheduled immunizations for the six basic Expanded Program on Immunization (EPI) antigens recommended by the WHO in 1974 [3] including Bacillus Calmette–Guérin (BCG), diphtheria–tetanus–pertussis (DTP), polio, and measles along with a seventh antigen, hepatitis B.

3.2. New and underused antigens

Uptake of newer EPI antigens is highly variable.

3.2.1. Haemophilus influenzae *type b*

Haemophilus influenzae type b (Hib) vaccination is scheduled in all ASEAN countries except for Thailand. The incidences of confirmed Hib meningitis in Thailand have been reported as 3.8/100,000 and 5.8/100,000 [4,5]. Thus, the lack of Hib vaccination in the Thai NIP may result from the low reported incidence rates; however, Thailand is reconsidering adding Hib.

3.2.2. Rubella

Rubella is scheduled in all ASEAN countries nationally except for Indonesia, Myanmar, and Vietnam. However, the Myanmar has added the measles–rubella (MR) vaccine in May, 2015. In preparation for this, a nationwide MR catch-up campaign for all children aged 9 months-15 years has been conducted since January 2015 [6]. To date, the Vietnamese NIP has not scheduled rubella. However, two studies in Vietnam between 2009–2010 and 2010–2011 reported incidence rates of congenital rubella syndrome to be 151/100,000 and 113/100,000, respectively [7,8]. Thus, the disease burden in Vietnam may warrant a NIP-based rubella-containing vaccine and further supplemental immunization activities (SIAs). A nationwide MR campaign to reach 23 million children aged 1–14 was conducted between September 2014 and February 2015. This was a global partnership between Vietnam and the Measles & Rubella Initiative led by the American Red Cross, the United Nations Foundation, the U.S. Centers for Disease Control and Prevention, United Nations Children's Fund (UNICEF) and the WHO. The MR vaccine may be introduced into the Vietnamese NIP soon [9].

3.2.3. Japanese encephalitis

Japanese encephalitis (JE) is endemic in South-East Asia [10]. Studies in Cambodia, Indonesia, Malaysia and Thailand have reported incidence rates of 11.1, 6, 1.5 and 25.6 (per 100,000 persons), respectively [11]. Subnational immunization targets high risk areas in Malaysia, Laos PDR and Vietnam whereas immunization is national in Thailand.

3.2.4. Rotavirus

Despite common reports of laboratory-confirmed rotavirus gastroenteritis amongst the <1-year-old age group in Laos PDR, Thailand and Vietnam [12], rotavirus vaccine (RV) is only included in the NIP of the Philippines. RV was introduced there subnationally in July 2012, targeting the most impoverished infants (first dose between 1 1/2 and 3 1/2 months of age) [13]. At present, a RV pilot study is in progress in one province of Thailand.

3.2.5. Pneumococcal

Invasive pneumococcal disease is common in the ASEAN region, especially amongst the ≤5 and ≥65 age groups. However, recent surveillance data is sparse. A study in rural Thailand between 2005 and 2010 reported incidence rates of pneumococcal bacteraemia amongst the ≤5 and ≥ 65 years age groups to be 11.7 and 14.2 (per 100,000 person-years), respectively, and these may have been underestimated due to the inclusion of only hospitalizations and the frequent use of pre-culture antibiotic [14]. Despite the high estimates of disease burden, the pneumococcal conjugate vaccine (PCV) is only available nationally in Cambodia, Laos PDR, the Philippines, and Singapore.

3.2.6. Human papilloma virus

The age-standardized incidence rate of cervical cancer in South-East Asia has been estimated to be 16.3/100,000 [15]. In ASEAN, only the NIPs of Brunei Darussalam, Malaysia, and Singapore currently offer human papillomavirus vaccine (HPV). The Philippines will introduce HPV subnationally in August, 2015 in the poorest provinces for girls aged 9. Laos PDR ran a 2-year Global Vaccine Alliance (Gavi)-funded HPV demonstration program in the Vientiane region amongst 10-year-old school girls starting in 2013 [16], and as of June 2015, HPV was national [17]. A pilot study is currently in progress in one province of Thailand.

4. Vaccine coverage rates in ASEAN countries

The ASEAN national vaccine coverage rates during 2014 are shown in Table 2. The Global Vaccine Action Plan (GVAP) has set a goal to reach ≥90% national coverage for vaccines in an NIP.

Table 2
Official national estimates of national vaccine coverage rates for 10 ASEAN countries.

	BCG	DTP3	Hep B3	HepB_BD	Hib3	MCV2	Polio3	Rotavirus_last	JE	PCV3	Rubella1
Brunei Darussalam	99	99	99	99	99	96	99	–	–	–	97
Cambodia	99	97	97	97	97	73	98	–	–	–	94
Indonesia	90	85	85	85	44	28	85	–	–	–	–
Laos PDR	82	88	88	–	88	–	88	–	–	72	87
Malaysia	99	97	96	90	97	99	97	–	–	–	94
Myanmar	92	88	88	–	88	82	88	–	–	–	–
Philippines	87	79	79	54	79	64	84	12	–	35	64
Singapore[a]	99	97	97	67	–	95	97	–	–	–	95
Thailand	99	99	99	99	–	94	99	–	92[b]	–	99
Vietnam	96	95	96	55	95	94	96	–	–	–	–

Abbreviations: BCG, Bacille Calmette Guérin vaccine; DTP3, third dose of diphtheria–tetanus–pertussis; HepB3, third dose of hepatitis B vaccine; HepB_BD, hepatitis B vaccine 1st dose <24 h after birth; Hib3, third dose of *Haemophilus influenza* type b vaccine; MCV2, 15–18 mo in countries with ongoing measles transmission or school entry if near elimination; Polio3, third dose of a poliomyelitis vaccine; Rotavirus_last, last dose of rotavirus vaccine; JE, Japanese encephalitis vaccine; PCV3, third dose of pneumococcal conjugate vaccine; Rubella1, first dose of rubella vaccine *Source:* Data from World Health Organization vaccine-preventable diseases: monitoring system, 2015 global summary. Available at: http://apps.who.int/immunization_monitoring/globalsummary/countries, as well as Singapore Ministry of Health data 2013.

[a] Singapore Ministry of Health data 2013.

[b] Three doses of Japanese encephalitis vaccine.

4.1. BCG

Eight ASEAN countries achieved the GVAP 2015 mid-point national coverage ≥90% except for Laos PDR (82%) and the Philippines (87%).

4.2. Three doses of DTP

Most ASEAN countries had a national coverage rate ≥90% except for Indonesia (85%), Laos PDR (88%), Myanmar (88%), and the Philippines (79%).

4.3. Three doses of hepatitis B vaccine

Most ASEAN countries reached the national coverage target of the GVAP of 90% except for Indonesia (85%), Laos PDR (88%), Myanmar (88%), and the Philippines (79%). The falling rate in 2013 in Myanmar compared with 2010 may have been caused by having introduced a DTwP-Hib-HepB vaccine in 2012.

The WHO recommends a dose of monovalent Hep B vaccine within 24 h after delivery for all newborns to prevent perinatal or early postnatal transmission that causes chronic infections [18]. Only Brunei Darussalam, Cambodia, Malaysia, and Thailand reported reaching national coverage ≥90%. The Philippines, Singapore, and Vietnam reached coverage rates of 54%, 67%, and 55%, respectively. Data was unavailable for Laos PDR, and Myanmar.

4.4. Haemophilus influenzae *type b*

Nine ASEAN countries have a Hib vaccine. Coverage rates were ≥90% for Brunei Darussalam, Cambodia, Malaysia, and Vietnam. The Indonesian subnational phased introduction of a locally produced DTwP-Hib-HepB pentavalent vaccine in 2013 may explain the very low coverage rate in Indonesia (44%).

4.5. Two doses of a measles-containing vaccine

Brunei Darussalam, Malaysia, Singapore, Thailand and Vietnam reached national coverage rates ≥90% for two doses of a measles-containing vaccine. The lowest rates were in the Philippines (64%) and Indonesia (28%).

4.6. Poliomyelitis vaccine

National coverage rates of ≥90% were reached by most ASEAN countries except for Indonesia (85%), Laos PDR (88%), Myanmar (88%), and the Philippines (84%).

4.7. Rotavirus

Rotavirus coverage in the Philippines was only 12% because the program to provide this vaccine to poor families under the National Household Targeting System of the Department of Social Welfare Development was scaled back from 17 provinces in 2013 to only Caraga and the Autonomous region in Muslim Mindanao in 2014. Also, the low coverage figure may have been due to incomplete reporting in those areas [19].

4.8. Japanese encephalitis

JE vaccine is used nationally only in Thailand, which achieved a national coverage rate of 92% in 2014.

4.9. Pneumococcal conjugate vaccine

Due to starting its nationwide PCV program in 2015, the Cambodian NIP is not represented in the tables derived from 2014 data. Laos PDR and the Philippines achieved national coverage rates of 72% and 35%, respectively.

4.10. Rubella

Seven ASEAN countries using rubella-containing vaccines achieved coverage rates >90% except for Laos PDR (87%) and the Philippines (64%).

5. Differences in DTP, poliomyelitis, Hib, measles, and JE vaccination schedules in ASEAN countries

Differences in vaccination schedules of DTP, poliomyelitis, Hib, measles, and JE in 2014 are shown in Table 3. The data was provided by workshop delegations and relevant regional WHO websites.

5.1. DTP

All ASEAN countries follow WHO recommendations [20]. Vaccine types used include the older whole cell pertussis vaccine

Table 3
Differences in vaccine schedules for DTP, poliomyelitis, Hib, measles, and JE.

	DTP	Poliomyelitis	Hib	Measles-containing vaccine	JE
Brunei Darussalam	Primary series acellular × 3 (2, 4, and 6 mo) Booster acellular × 1 (5 yr)	Primary series IPV × 3 (2, 4, and 6 mo) Booster IPV × 1 (5 yr)	Primary series DTaP-Hib-HepB-IPV × 3 (2, 4, and 6 mo) Booster Hib × 1 (12 mo)	MMR × 2 (12 and 18 mo)	
Cambodia	Primary series whole cell × 3 (6, 10, and 14 wk)	Primary series OPV × 3 (6, 10, and 14 wk)	Primary series DTwP-Hib-HepB × 3 (6, 10, and 14 wk)	MR × 1 (9 mo) + measles (18 mo)	
Indonesia	Primary series whole cell × 3 (2, 3, and 4 mo) Booster whole cell × 1 (18 mo)	Primary series OPV × 4 (1, 2, 3, and 4 mo) or IPV × 3[a] (2, 3 and 4 mo)	Primary series DTwP-Hib-HepB × 3 (2, 3, and 4 mo) Booster DTwP-Hib-HepB x 1 (18 mo)	Measles × 2 (9 mo, (24 mo[a]) and 6–7 yr)	
Laos PDR	Primary series whole cell × 3 (6, 10, and 14 wk)	Primary series OPV × 3 (6, 10, and 14 wk)	Primary series DTwP-Hib-HepB × 3 (6, 10 and 14 wk)	MR × 1 (9 mo)	Live attenuated × 1[a] (9 mo)
Malaysia	Primary series acellular × 3 (2, 3, and 5 mo) Booster acellular × 1 (18 mo)	Primary series IPV × 3 (2, 3, and 5 mo) Booster IPV × 1 (18 mo) + OPV × 1 (7 yr)	Primary series DTaP-Hib-IPV × 3 (2, 3, and 5 mo) Booster DTaP-Hib-IPV × 1 (18 mo)	MMR × 2 (12 mo and 7 yr)	Live attenuated × 2[a] (9 and 12 mo)
Myanmar	Primary series whole cell × 3 (2, 4, and 6 mo)	Primary series OPV × 3 (2, 4 and 6 mo) + IPV × 1 (4 mo)	Primary series DTwP-Hib-HepB × 3 (2, 4 and 6 mo)	Measles × 2 (9 and 18 mo)	
Philippines	Primary series whole cell × 3 (6, 10, and 14 wk)	Primary series OPV × 3 (6, 10 and 14 wk) + IPV × 1[a] (14 wk)	Primary series DTwP-Hib-HepB × 3 (6, 10, and 14 wk)	Measles × 1 (9 mo) + MMR × 1 (12-15 mo) + MR × 1[a] (12–13 yr)	
Singapore	Primary series acellular × 3 (3, 4, and 5 mo) Booster acellular × 1 (18 mo)	Primary series OPV × 3 (3, 4, and 5 mo) Boosters OPV × 3 (18 mo, 6–7 yr, and 10-11 yr)	Primary series DTaP-IPV-Hib × 4(3, 4, and 5 mo)[b] Booster DTaP-IPV-Hib × 1 (18 mo)	MMR × 2 (12 and 15-18 mo)	
Thailand	Primary series whole cell × 3 (2, 4, and 6 mo) Booster whole cell × 2 (1.5 and 4 yr)	Primary series OPV × 3 (2, 4, and 6 mo) Booster OPV × 2 (1.5 and 4 yr)		MMR × 2 (9 mo and 2.5–6 yr)	MBJEV × 3 (2 doses at 1.5 yr, 1.5 yr + 2 wk and 2.5 yr)
Vietnam	Primary series whole cell × 3 (2, 3, and 4 mo) Booster whole cell × 1 (18 mo)	Primary series OPV × 3 (2, 3 and 4 mo)	Primary series DTwP-Hib-HepB × 3 (2, 3, and 4 mo)	Measles × 2 (9 and 18 mo)	MBJEV × 2 (2 doses at 12 mo, 12 mo +2 wk and 2 yr)

Abbreviations: JE, Japanese encephalitis; IPV, inactivated polio vaccine; OPV, oral polio vaccine; DTaP, diphtheria-tetanus- acellular pertussis; DTwP, diphtheria-tetanus- whole cell pertussis; HepB, hepatitis B virus vaccine; Hib, *Haemophilus influenza* type b; MMR, measles–mumps–rubella vaccine; MR, measles-rubella vaccine; measles, measles monovalent vaccine; MBJEV, mouse brain-derived Japanese encephalitis vaccine *Source:* Data from World Health Organization vaccine-preventable diseases: monitoring system, 2015 global summary. Available at: http://apps.who.int/immunization_monitoring/globalsummary/countries.

[a] Subnational use.

[b] Data from the Ministry of Health of Singapore.

(DTwP) and a newer acellular pertussis vaccine (DTaP). DTwP has been associated with side effects ranging from common local adverse events to rare severe systemic events such as convulsions with or without fever and hypotonic hyporesponsive episodes [21]. However, it confers better initial and longer lasting immunity than the DTaP [22]. DTaPs were developed during the 1980s from purified antigenic components of *Bordetella pertussis* because of their lesser incidence of adverse events following immunization (AEFI) compared to DTwPs [23]. Safety fears about DTwP in some populations and anti-immunization groups may be diminished by introducing a DTaP. Brunei Darussalam, Singapore, and Malaysia use the DTaP. However, the latest WHO position paper recommends that countries only switch to acellular pertussis vaccine if sufficient financial resources to provide boosters for this relatively expensive vaccine exist [24]. This recommendation was made after animal models and surveillance data suggested that waning immunity in older persons may lead to infections of very young unvaccinated infants when DTaP is widely used [24].

5.2. Poliomyelitis

The 68th World Health Assembly (WHA) has passed resolutions that support the WHO's "Polio Endgame Strategy" [25]. An oral polio vaccine (OPV)-only schedule is not recommended, and NIPs should add at least one dose of an inactivated poliovirus vaccine (IPV) [20]. This protects against type 2 poliovirus. The choice of OPV and IPV combination is complex. Low income countries in polio endemic areas and countries with a high risk of importing infections should give a dose of OPV at birth followed by a primary series of three doses plus a dose of IPV at 4 months or 14 weeks [26]. Myanmar follows WHO-recommended schedule nationally while the IPV dose in the Philippines is subnational. Cambodia is introducing IPV into its NIP and expects to complete the process by the end of 2015. In contrast, Malaysia uses a sequential IPV-OPV schedule. This is suitable due to the high coverage rate and low risk of importing infection in Malaysia [26]. Sequential IPV-OPV schedule usage may reduce the incidence of vaccine associated paralytic poliomyelitis with the OPV dose providing mucosal immunity [26].

5.3. Haemophilus influenzae *type b*

Nine ASEAN countries with a Hib vaccine use a combination vaccine, allowing convenient administration. Brunei Darussalam provides a monovalent Hib booster while Indonesia and Malaysia give a further dose of a Hib-containing combination vaccine.

5.4. *Measles-containing vaccine*

The WHO recommends at least two doses of a measles-containing vaccine with a first dose as soon as possible after loss of maternal antibody protection [20]. A first dose given at 8–9 months caused a median proportion of seroconversion of 89.6% (interquartile range, 82–95%) and given at 11–12 months a median proportion of seroconversion of 99% (interquartile range, 93–100%) [26]. No differences in immunogenicity and reactogenicity between measles only or measles-containing combination vaccines have been reported [27]. Thus, the level of transmission determines the choice of vaccine type and schedule. Various vaccine types are used in the ASEAN region including monovalent measles, MR and measles–mumps–rubella. All countries except for Laos PDR and Malaysia use at least two doses according to WHO recommendations. Laos PDR offers one dose at 9 months of age.

5.5. *Japanese encephalitis*

Because of their medium to high incidence rates, JE vaccination is suitable for Cambodia, Indonesia, Malaysia, Myanmar, Laos PDR, the Philippines, Thailand, and Vietnam [10]. The WHO further recommends switching from mouse brain-derived JE vaccines (MBJEV) to non-MBJEV due to incidence of AEFI in the former [28]. Currently, Laos PDR and Malaysia exclusively use a non-MBJEV, a live attenuated vaccine of one dose at 9 months of age and two doses at 9 and 12 months, respectively. Both Thailand and Vietnam continue to use a MBJEV in a two-dose primary series with a one dose booster. In Thailand, the first dose can be given as early as 9 months of age with the second dose given at least 2 weeks later and a third dose given around 2 to 2 1/2 years of age. Currently, a pilot study of the live attenuated vaccine is being conducted in eight provinces of Thailand.

6. Selected achievements to date

Regional EPI goals of three doses of DTP (DTP3) at a high national coverage (≥90%) and district coverage (≥80%), the elimination of

Table 4
Vaccine preventable disease goals, selected achievements to date for WHO Regional Offices in ASEAN.

	DTP3 routine immunization coverage	Maternal and neonatal tetanus elimination	Polio eradication	Measles/rubella elimination
Goal	**WHO SEAR** High DTP3 coverage in every district by 2015 **WHO WPR** High DTP3 coverage in every district by 2015	**WHO SEAR** Eliminate NT by 2015 Sustain MNT elimination **WHO WPR** Eliminate MNT by 2015 Validate elimination by 2016 Maintain elimination based on WHO/UNICEF District Data Spreadsheet	**WHO SEAR** Regional polio-free certification by 2014 Sustain regional WHO-certified polio-free status **WHO WPR** Sustain regional WHO-certified polio-free status	**WHO SEAR** Eliminate and control measles/rubella/CRS by 2020 **WHO WPR** Elimination of measles by 2012 Eliminate rubella/CRS (no current consensus of target date)
Definition of goal	≥90% DTP3 coverage nationally and ≥80% in each district of a country	<1 NT case/1,000 live births in every district of the country	No cases of WPV for 3 consecutive years with certification standard surveillance	No endemic measles cases, no endemic rubella cases, and no CRS cases associated with endemic transmission for 3 consecutive years with certification standard surveillance
Selected achievements to date	**WHO SEAR** All ASEAN countries in WHO SEAR have achieved ≥90% DTP3 coverage nationally except for Indonesia and Myanmar **WHO WPR** All ASEAN countries in WHO SEAR have achieved ≥90% DTP3 coverage nationally except for Laos PDR, and the Philippines	**WHO SEAR** All countries have regional MNT-free certification except for one region of Indonesia (validation expected in 2016) **WHO WPR** All countries have regional MNT-free certification except for the Philippines (validation expected in 2015)	**WHO SEAR** Region polio free since January 2011 Regional polio-free certification in 2014 **WHO WPR** Region polio free since April 1997 Regional polio-free certification in 2000[a]	**WHO SEAR** No ASEAN countries in WHO SEAR have achieved ≥95% MCV2 SIAs: Measles follow-up campaigns Indonesia in 2011 Myanmar in 2007 MR catch-up campaigns Myanmar in 2014, 2015 **WHO WPR** Brunei Darussalam, Malaysia, and Singapore have achieved ≥95% MCV2. SIAs: Measles follow-up campaigns Cambodia in 2011 Laos PDR PDR in 2007 Philippines 2007 Vietnam 2003, 2005, 2006 and 2010 MR catch-up campaigns Cambodia in 2013 Laos PDR in 2011 Phillippines 2014 Vietnam 2014, 2015[a]

Abbreviations: DTP3, third dose of diphtheria–tetanus–pertussis vaccine; WHO SEAR, World Health Organization South-East Asia Regional Office; WHO WPR, World Health Organization Western Pacific Regional Office; NT, neonatal tetanus; MNT, maternal and neonatal tetanus; CRS, congenital rubella syndrome; WPV, wild poliovirus; MCV1, first dose of a measles-containing vaccine; MCV2, second dose of a measles-containing vaccine; MR, measles–rubella vaccine. *Main sources:* WHO SEARO. Report of the 4th Meeting of the South-East Asia Regional Immunization Technical Advisory Group. New Delhi 2013; WHO WPR. Report of the Technical Advisory Group on Immunization and Vaccine-Preventable Diseases in the Western Pacific Region, Manila 2014; WHO WPR. Expanded Programme on Immunization: Regional Framework for Implementation of the Global Vaccine Action Plan in the Western Pacific, Manila 2014. Other sources.

[a] The Measles and Rubella Initiative. Financial Resource Requirements for Measles and Rubella Elimination 2015-2020. http://www.measlesrubellainitiative.org/wp-content/uploads/2014/08/MRI-Financial-Resources-Requirement-Report.

maternal neonatal tetanus (MNT) and MR, as well as the eradication of polio are shown in Table 4.

To date, the ASEAN region has achieved WHO certification of polio-free status and is nearing validation of MNT-free status. Only Indonesia and the Philippines are not yet MNT-free validated, and these countries are expected to be validated by 2016.

Unfortunately, goals for DTP3 coverage and MR have not been reached. National DTP3 coverage ≥90% also has not been achieved in Indonesia, Laos PDR, Myanmar, and the Philippines. Brunei Darussalam and Cambodia received certification for elimination of measles on 31 March, 2015 and 25 June, 2015, respectively. Nevertheless, coverage is of the second dose of a measles-containing vaccine in some ASEAN countries considerably worse than coverage of the first dose. Despite NIP-based measles immunization along with follow-up and catch-up SIAs in Cambodia, Indonesia, Laos PDR, the Philippines, and Vietnam, measles has been resurgent in Indonesia, Laos PDR, Malaysia, the Philippines, Singapore, Thailand and Vietnam. These countries have reported incidence rates >10 per 1 million of population in 2014 [29].

7. Discussion

The 68th WHA, held in May, 2015, made resolutions that urge WHA member states to support various WHO-coordinated partners in design and implementation of strategies to close vaccine and immunization gaps in low-middle-income countries, to strengthen immunization advocacy, to adequately fund currently used and new vaccines, to pool vaccine procurement, to share vaccine pricing and government funding data, to improve and sustain purchasing and delivery, and to improve health care worker training [30]. These resolutions along with the presentations and discussions during the workshop have revealed five broad issues to address to realize the full potential of vaccines in ASEAN, namely equity, advocacy, vaccine security, human and health care facilities resources, as well as surveillance and monitoring.

7.1. Equity

7.1.1. Challenges

Many delegations at the workshop reported inequity challenges of access to vaccines. Hard-to-reach populations include ethnic minorities, geographically or socially isolated groups such as urban legal and illegal migrants. Lower coverage rates in these populations may prevent the eradication of vaccine preventable diseases (VPD).

7.1.2. Solutions

One solution for inequity amongst hard-to-reach populations is SIAs. Indeed, SIAs have been recommended as necessary to eliminate or eradicate measles, rubella, and poliomyelitis in countries with weaker NIPs. For example, measles elimination requires a vaccination coverage of at least 95% of the population at the national and district levels with two doses of a measles containing vaccine [31]. Countries with weaker NIPs should conduct one-time catch-up campaigns and subsequent campaigns to vaccinate children from 0 to 14 years of age, especially for the second dose [31]. Cambodia has conducted a series of measles and polio SIAs from 2000 to 2013. Myanmar has been running polio SIAs and will run MR SIAs in 2015. Laos PDR and Thailand reported that they are also considering vaccination programs for hard-to-reach groups.

7.2. Advocacy

7.2.1. Challenges

Promoting and educating vaccinations amongst stakeholders and end-users in every community is essential to achieve GVAP targets by 2020. Advocacy issues in vaccination reported during the workshop included availability, awareness, basic vaccine education, communication between medical societies and government, and anti-immunization movements.

7.2.2. Solutions

To promote vaccine awareness and education, public health promotion campaigns including talks, the Internet, and social media have been conducted in Indonesia, Laos PDR, Malaysia, and Myanmar. Such campaigns involve health care worker advocates and often celebrity endorsements to increase media interest. Advocacy to government is critical in policy-making and recruiting resources for NIPs.

The Philippines has been particularly successful in this aspect. Some laws have been recently introduced to support NIPs. For example, from alcohol and cigarettes, one-third of the revenues from the SIN tax subsidize universal health care [32]. The Pediatric Infectious Disease Society of the Philippines has successfully strongly advocated periodic budget increases with the government. The Filipino delegate, Dr S Gatchalian, stated that the budget has increased from $3.42 million to $49.19 million from 1983 to 2013, expanding the NIP and including new and underused vaccines such as RV nationally in 2013. During the workshop, the delegates from Indonesia and Malaysia strongly emphasized their non-confrontational pro-immunization campaign strategies by publications, websites, seminars and social media to correct anti-immunization movement disinformation [33,34]. In these countries, advocacy to religious and community leaders is also important due to their strong influence within local communities.

7.3. Vaccine security

7.3.1. Challenges

The workshop highlighted that NIPs need secure multi-year production, financing, wastage reduction, and long-term vaccine requirement forecasting.

7.3.2. Solutions

To address the issue of multi-year production, some domestic vaccine production capacity has been developed in Malaysia, Vietnam and Thailand. In particular, Vietnam is able to produce its NIP vaccines including BCG, cholera, DTP, hep B, Hib, JE, measles, and tetanus. The Vietnamese delegate, Dr Pham Nhat An, stated that because some Vietnamese prefer brand name foreign vaccines from the private health care sector due to supposed potency and risk of AEFI concerns about domestically manufactured vaccines. This causes them to wait for new stock of brand name foreign vaccines when they are temporarily unavailable. This causes gaps in vaccine coverage.

Financially, ASEAN can be divided into Gavi eligible and non-eligible countries. Gavi is a non-profit organization intended to improve access to new and underused vaccines for children in the poorest countries. Financial and expert contributions for Gavi come from the Bill and Melinda Gates Foundation, UNICEF, WHO, and the pharmaceutical industry. Gavi eligibility is based on a gross national income per capita below or equal to US$ 1580 [35]. ASEAN countries currently eligible for Gavi funding are Cambodia, Laos PDR, and Myanmar. Indonesia and Vietnam will not receive Gavi funding after 2015 because their gross national incomes per capita exceed the eligibility threshold. Other ASEAN countries do not receive Gavi support. These statuses influence the introduction of new and underused vaccines. The low income country of Myanmar plans to introduce new antigens such as rubella, pneumococcal, and rotavirus within two years, and Cambodia plans to introduce IPV, JE and HPV by 2016. These new NIP vaccines will be partially funded by Gavi. Middle income countries without Gavi funding are limited

by the financial burden of raising budgets for new and underused vaccines domestically.

Cold chains to avoid wastage and loss of potency also require budgetary increases. For example, Dr S Gatchalian, stated that introducing PCV, IPV and HPV nationwide in the Philippines by 2016 requires an NIP budgetary increase from around $72 million in 2015 to $160 million in 2016. Although the Philippines has successfully appropriated this budget by strong advocacy and legislation, NIPs in other middle income countries compete with other important social issues for funding. The Thai delegate, Dr C Muangchana, suggested that regional price sharing and pooled procurement similar to the Pan American Health Organization may help to solve the increasing financial burden of expanding NIPs in ASEAN. Dr JM Okwo-Bele suggested that such initiatives should start on a smaller scale between ASEAN partners rather than attempting a pan-ASEAN partnership.

7.4. Human and health care facilities resources

7.4.1. Challenges

Trained health care workers to administer vaccines and manage the supply chain along with accessible and good standard fixed and mobile service points are concerns for middle and in particular low income countries. During the workshop, the Cambodian, Laotian, the Filipino and Vietnamese delegations were concerned about a lack of trained health care workers. Dr Pham Naht An stated that some of the 43 serious AEFI in Vietnam were caused by errors in vaccine administration by health care workers in rural areas due to lack of both training and higher level health facilities. Myanmar also lacks higher level health facilities. With a very large rural area and proportion of the population, the Burmese delegate, Dr Ye Myint Kyaw, stated that only 30% of births in Myanmar are hospital based while the remainder are home or in local settings based. Thus, coverage rates for hep B virus <24 h after delivery and BCG remain low because of missed opportunities for vaccination.

7.4.2. Solutions

No solutions to these issues were discussed during the workshop.

7.5. Surveillance and monitoring

7.5.1. Challenges

Disease surveillance and a true understanding of the burden of VPD are crucial in informing decisions and policy-making about NIPs. Monitoring and assessing NIPs can assess their performance, quality, and safety. The GVAP monitoring and evaluation/accountability framework needs administrative and survey data from GVAP member states for the deliberations of the WHO Strategic Advisory Group of Experts on Immunization and WHA to inform policy-making [36]. Regional WHO technical advisory groups along with the Cambodian, Thai and Singaporean delegations at the workshop all mentioned some insufficiencies in evidence base to inform national policy-making about current and new antigens for NIPs [37,38].

7.5.2. Solutions

At the workshop, Dr C Muangchana suggested that special epidemiological surveys for estimating disease burden and serological monitoring for estimating immune responses are needed. He also suggested more studies are required to assess the performance of service logistics and NIP health care worker practices. Another important practical tool is a national immunization registry database for keeping vaccination records and automatically prompting health care workers about patients requiring vaccination. Currently, only Singapore operates such a system. Another issue is outbreak surveillance and reporting. For example, recommendations about measles by regional WHO technical advisory groups urge all ASEAN countries to complete regional surveillance guidelines, initiate case-based reporting and report individual case-based data monthly to the WHO country offices and Regional Office [37,38].

8. Conclusion

The Singaporean moderator, Dr Tikky Pangestu, succinctly summarized the contents of the workshop in his closing remarks. ASEAN has made good progress in access and procurement of vaccinations. However, challenges in diversity, fragility, and fragmentation remain. Diversity exists in cultures, societies, forms of government, and health financing systems. Fragility of NIPs is caused by weaker healthcare delivery systems, insufficient research into disease burden of VPDs, and surveillance. Fragmentation of coherent NIP delivery to end users results from the parallel provision of vaccines by the public and private health services, from the availability of foreign and local manufacturers and from varying approaches to advocacy and access to vaccines. Dr JM Okwo-Bele closed the workshop by emphasizing four key challenges in ASEAN NIPs. The region's NIPs must close vaccination gaps, improve demand for vaccines, improve surveillance data, and provide vaccine security. Finally, he urged the workshop delegates to continue to advocate for NIPs with policy-makers through meetings such as this first Workshop on National Immunization Programs and Vaccine Coverage in ASEAN Countries.

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Conflicts of interest statement

The authors have no conflicts of interest. WH collected the data and wrote the manuscript. KP and UT assisted in all aspects of the report including the data analysis and preparation of the manuscript.

Appendix A. Delegates of the 1st Workshop on National Immunization Programs and Vaccine Coverage in ASEAN Group[1] (in alphabetical order of last names)

Pham Nhat An, MD (Chair of Pediatric Department, Hanoi Medical University, Vietnam).

Thoon Koh Cheng, MD (Representative of the Singapore Paediatric Society, Singapore).

Salvacion R. Gatchalian, MD (President of Pediatric Infectious Disease Society of the Philippines, the Philippines).

Hartono Gunardi, MD (Deputy to the President of Indonesian Pediatric Society, Indonesia).

Ye Myint Kyaw, MD (President of Myanmar Pediatric Society, Myanmar).

Kok Chin Leong, MD (President of ASEAN Pediatric Federation and President of the Malaysian Pediatric Association, Malaysia).

Charung Muangchana, MD (Director, National Vaccine Institute, Ministry of Public Health, Thailand).

Khampe Phongsavath, MD (Director of Sethathirath Hospital, Laos PDR).

Yit Sunnara, MD (President of Cambodian Pediatric Association, Cambodia).

Yung Chee Tee, MD (Senior Medical Officer, Ministry of Health, Brunei Darussalam).

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