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Research Article

Measles Control in Pacific Island Countries and Territories

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Abstract

Historically, measles has been a public health concern since the nineteenth century in Pacific Island Countries and Territories (PICTs). Now, despite significant progress, immunization programmes in these countries face many challenges, gains remain fragile, and outbreaks continue to occur. While most PICTs have achieved relatively high measles vaccine coverage, they need to achieve and sustain very high coverage of two doses of measles vaccine for each annual cohort of infants to prevent a build-up of unimmunized children and the risk of a measles outbreak. In line with global experience, there are indications of stagnation in routine coverage in recent years in some countries, resulting in an on-going risk of an outbreak if measles virus were to be imported from neighbouring countries.

PICTs tend to experience a range of difficulties related to delivery of immunization services that are specific to the island environment. Challenges include generalized systemic weaknesses in the health system; ensuring the supply of vaccines to remote locations; frequent natural disasters such as cyclones; highly mobile populations; and pressure on limited resources. If governments become more pressured from the mounting epidemics of non-communicable diseases, funding for immunization services may suffer as a consequence. The support of international stakeholders for measles control will remain essential for many PICTs for the foreseeable future.

ABBREVIATIONS

PICTs: Pacific Island Countries and Territories; WHO: World Health Organization; WPR: Western Pacific Region of WHO; SIA: Supplementary Immunization Activities; MCV: Measles-Containing Vaccine

INTRODUCTION

While island populations might possess certain advantages regarding natural protection against communicable diseases, in reality they face specific problems that make them potentially vulnerable to measles infection. Historically, measles outbreaks have had a devastating effect on Pacific island countries. In 1875 between 27,000 and 50,000 Fijians died during a catastrophic outbreak of measles introduced into a non-immune population. Other Pacific islands have suffered similarly. One twentieth of the Tongan population died from measles in the outbreak of 1893 [1]. Even today, measles continues to take its toll in the Pacific, generating recent measles outbreaks in, for instance, Micronesia, Solomon Islands and Vanuatu in 2014 and 2015 [2].

The 22 countries and territories known as the Pacific Island Countries and Territories (PICTs) (Table 1), are part of the Western Pacific Region (WPR) of the World Health Organization (WHO). They are considered as one epidemiological block for the purposes of measles surveillance. Papua New Guinea (PNG) has around 7 million populations, and the remaining 21 PICTs jointly having only around 3 million. In contrast, the rest of the WPR has a population of around 1,850,000,000. It is clear that although the PICTs are included in the WPR, their population numbers and geographical environment are profoundly different from most of the other countries in the region. As would be expected, their island environment influences the epidemiology of communicable diseases and vaccine preventable diseases (VPDs) such as measles.

Despite significant progress in controlling measles, PICTs still face many challenges, and gains remain fragile. There is extensive population mobility within and between islands, and substantial migration to urban centers in some locations. Countries are susceptible to climate change, extreme weather events including cyclones, floods and other disasters that can disrupt regular services for many months. PICTs tend to experience a range of difficulties related to equitable delivery of services to remote, scarcely populated islands and to weaknesses in the underlying

Table 1: Twenty-two Pacific Island Countries and Territories.

The Secretariat for the Pacific Community (SPC) [3] membership includes 22 Pacific Island countries and Territories: American Samoa, Cook Islands, Federated States of Micronesia (FSM), Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea (PNG), Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna.

health system that limit provision of quality primary health care, including immunization services, to all communities.

METHOD

A review of the immunization programmes in 22 PICTs was conducted in two stages during July 2015. The first stage consisted of an extensive desk review of key materials related to immunization in all PICTs over the past 10 years. The second stage consisted of visits to three countries (to Solomon Islands, Samoa and Kiribati) selected to cover three rather different political and social environments. During country visits, the team interviewed development partners, key informants in ministries of health and other ministries, and staff at a range of service levels, health facilities and vaccine stores. The interview addressed a range of issues/questions. But not all issues were applicable to every country, and not every staff member interviewed was asked all the questions. The team provided feedback at the end of each country visit and held a debriefing session of findings and recommendations for representatives of the regional health organizations in Suva, Fiji. The review team comprised of a health specialist and team leader, and an immunization specialist. We were joined for the country visits by staff from the Secretariat of the Pacific Community (SPC) and sub-regional offices of WHO and the United Nations Children's Fund (UNICEF), thereby adding further depth and insights. The full reports of the findings of the review are published elsewhere [4].

RESULTS AND DISCUSSION

Immunization coverage rates for measles-containing vaccines (MCVs) were found to be generally high in PICTs, but there is a recent trend towards declining or stagnant levels in the last two to three years, consistent with the global trend (Figure 1). There is also considerable variation in reported coverage both between and within countries and between years.

Routine and supplementary immunization activities (SIAs) have dramatically reduced the number of reported measles cases in PICTs. The MCV schedules of PICTs vary considerably-the first dose (MCV-1) being given at 12-15 months and a second dose (MCV-2) between 13 months and 6 years. As of 2015, all but two of the PICTs provided a second dose of MCV. Table (2) shows countries in red that are achieving less than 80% coverage for MCV-1 or MCV-2.

Despite attempts to reach and maintain high coverage with routine immunization coverage and SIAs, these efforts have not been enough to eliminate measles, with outbreaks occurring in several PICTs in the last decade (Table 3).

Recent outbreaks of measles have largely been limited to the few fragile and least developed countries that have failed to achieve consistent high levels of MCV coverage [5]. Populations at highest risk for exposure to measles virus may be among persons from countries or territories that have historical associations with other countries that are currently experiencing measles outbreaks. These include Solomon Islands because of their low coverage and proximity and frequent cross border exchange of goods and services with PNG; and the U.S.-affiliated countries and territories (American Samoa, Guam, Mariana Islands, Marshall Islands, Micronesia, and Palau) and their relationship with the Philippines. The previously low immunization coverage in Vanuatu has also made it vulnerable to outbreaks. In 2014, the Federated States of Micronesia (FSM), Solomon Islands and Vanuatu faced measles outbreaks due to importations. On a positive note, these outbreaks were interrupted within 6 weeks to 4 months [6].

CASE STUDY - SOLOMON ISLANDS 2014

The Solomon Islands experienced a measles outbreak in June 2014 after a traveler returned from Papua New Guinea [7]. A total of 4,654 suspected measles cases were reported subsequently, with 38 cases having been confirmed by serology. Most cases were from the densely populated islands of Honiara, Guadalcanal, and Malaita. Following this outbreak, a Measles-Rubella (MR) SIA was launched in a phased manner in September to target all age groups from 6 months to 30 years. The campaign commenced in Honiara, the epicenter of the outbreak, and was rolled out in the provinces as resources permitted.

MCV-1 routine coverage in Solomon Islands had ranged from 60% to 96% during the period 1990-2013, rising to 93% in 2014 [8]. Although no measles cases had been reported to WHO since 1990 (when there were 343 cases) such mediocre coverage made Solomon Islands vulnerable to an outbreak. MCV-2 had not yet been introduced. There had been a national SIA in 2012, but this SIA did not prevent such a large outbreak from occurring in 2014-only two years later. The national coverage for MCV in the SIA in 2012 was 101% (and 90.6% for vitamin A). Many of the cases were in adolescents and young adults who would have been missed in earlier efforts to immunize.

National coverage for the 2014 post-outbreak SIA was 106% for MCV and 46% for vitamin A. Provincial reported coverage ranged from 91% to 130% (Figure 2). Those locations with coverage rates in excess of 100% probably represent a mix of cross-border population movements and vaccination outside the official age range (i.e. vaccination of older children who showed up during the SIA).

Certain problems were identified in retrospect. In the remote and hard-to-reach areas with scattered islands, there were inadequate numbers of outreach and mobile teams and inadequate appropriate transport. Some funds were delayed reaching provinces. Vaccines and supplies were delayed, resulting in the need for the campaign to be rolled out in separate phases instead of being conducted simultaneously in all provinces. None the less, high coverage was achieved and the outbreak stopped.

Table 2: Measles-containing vaccine coverage in selected PICTs 2010-2014.

Year	Coverage (%)									
	2010		2011		2012		2013		2014	
	MCV1	MCV2	MCV1	MCV2	MCV1	MCV2	MCV1	MCV2	MCV1	MCV2
Am Samoa	No data								85	N
Cook Islands	99	98	89	96	97	98	97	95	98	98
Fiji	94	94	94	94	94	94	94	94	94	94
French Polynesia	No data								~99	N
Guam	No data								82	N
Kiribati	89	21	91	61	91	9	91	84	91	84
Marshall Islands	97	90	88	74	78	58	79	56	79	53
Federated States of Micronesia	80	75	92	75	91	70	91	75	91	75
Nauru	99	99	99	99	96	81	97	88	98	94
New Caledonia	No data								~99	N
Niue	99	99	99	98	99	98	99	99	99	99
Palau	39	39	86	83	91	86	99	98	83	81
PNG	55	--	60	--	67	--	70	--	65	--
Samoa	61	45	67	65	85	67	99	87	91	78
Solomon Islands	85	--	90	--	99	--	93	--	93	--
Tonga	68	67	66	66	62	62	67	67	67	67
Tuvalu	85	87	98	90	98	93	96	84	96	84
Vanuatu	53	--	53	--	5	--	53	--	53	--

Source: Data from WHO country profiles. Data are estimates made by WHO and UNICEF.
Data in RED are for values less than 80%.
Data in YELLOW for values between 94% and 80%
Data in GREEN are values of 95% and above
-- MCV-2 does not part of routine schedule

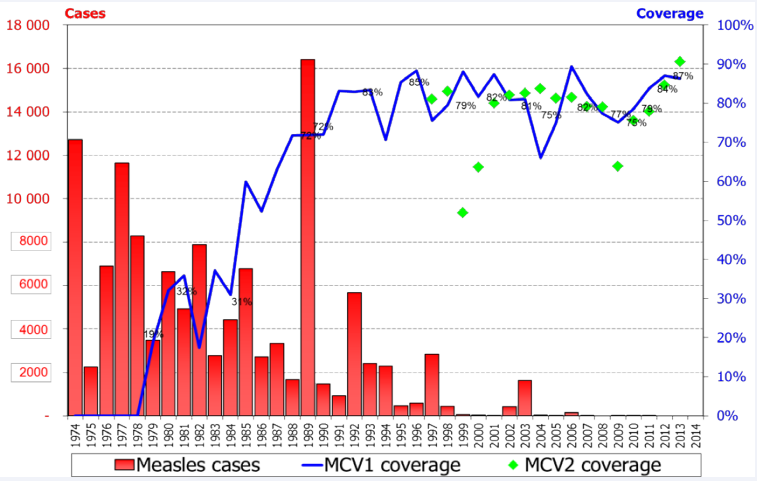

Figure 1 Measles cases and MCV coverage in PICTs, 1974-2013
Source: WHO, Fiji Office

CASE STUDY-REPUBLIC OF MARSHALL ISLANDS (RMI) 2003

Measles epidemics had occurred previously in RMI in 1968 [5], 1978 and 1988 (CDC unpublished data). The introduction of mumps, measles, rubella (MMR) vaccine was in 1982 at 9 months of age. This was augmented to a 2-dose schedule in 1998. Between 1994 and 2002, three SIAs were also conducted.

Until the outbreak of measles in RMI in 2003 [9], there had been no measles cases reported since 1989. SIAs had been used to supplement routine measles vaccination during this period. Reported routine MCV-1 coverage among children aged 12-23 months varied widely (52–94%) between 1990 and 2000. Cluster

Table 3: Confirmed measles cases by month of onset, June 2014 – May 2015, WHO Western Pacific Region.

Country	2014							2015				
	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Australia	34	32	23	2	17	5	14	10	6	11	9	0
Brunei Darussalam	0	0	0	0	0	0	0	0	0	0	0	0
Cambodia	0	0	0	0	0	0	0	0	0	0	0	0
China	6113	3779	2007	1033	778	755	1356	2359	4312	5767	7937	7035
China, Hong Kong SAR	4	7	3	3	1	0	0	0	1	1	2	2
China Macao SAR	1	0	0	0	0	0	0	0	0	0	0	0
Japan	38	12	19	5	2	6	2	1	2	3	10	2
Lao DPR	0	0	0	28	36	1	0	0	2	0	0	0
Malaysia	18	19	19	17	23	7	13	16	25	46	68	39
Mongolia	0	0	0	0	0	0	0	0	0	159	262	124
New Zealand	98	31	5	0	1	3	0	0	2	2	2	3
PNG	640	259	64	29	10	37	21	34	4	7	2	0
Philippines	1260	1305	1386	957	448	204	45	150	190	133	54	12
Republic of Korea	44	25	3	2	1	0	0	0	0	4	1	0
Singapore	6	12	9	0	2	0	2	2	3	2	7	1
Viet Nam	457	257	210	170	155	38	10	38	14	12	19	8
PICTs	128	114	9	3	2	0	0	3	2	7	0	0
Western Pacific Region	8841	5852	3757	2249	1476	1056	1463	2613	4563	6154	8373	7226

Source: Case-based and aggregated data reports to the WHO Western Pacific Regional Office by 20 June 2015.
Legend: SAR – Special Administrative Region
DPR – Democratic People's Republic

surveys among children aged 2 years in 1998 and 2001 showed 93% and 80% MCV-1 coverage rates, respectively.

In the outbreak, there were 826 measles cases reported, of which 766 (92%) were in the capital Majuro. Of those, 186 (23%) were in infants aged less than 1 year, and 309 (37%) were in persons aged less than 15 years. More than half (59%) of the cases aged less than 15 years had not been immunized prior to the SIA. One hundred cases were hospitalized, of which 3 died. Coverage for the SIA consequential on the outbreak was 93%, targeting persons aged 6 months to 40 years.

For 10 days after the start of the outbreak, domestic air and sea travel was interrupted, and the start of the school year was postponed for a week. Immunization teams focused on school-aged children, even visiting the outlying islands. Evidence of vaccination was required for school entry. Rapid implementation of control and prevention efforts in the Outer Islands and Ebeye confined the outbreak primarily to Majuro, the atoll most populated. Spread to other countries was probably limited by the unprecedented requirement that departing international passengers had to show evidence of measles immunization. It would have helped that localities where importation might have occurred generally had high population immunity.

The population of RMI at the time of the outbreak was around 51,800.The island of Majuro had around 6,700 persons per square mile, and Ebeye had a population density of 96,300 persons per square mile, for a total of around 36,000 persons between them. This extremely high-density situation undoubtedly contributed to the size and rapid spread of the outbreak. During the outbreak, Marin et al. [10], concluded that measles vaccine effectiveness was high; thus, diminished vaccine effectiveness was not the main cause of the outbreak, rather the inadequate vaccine coverage levels in the context of a very high population density.

MAIN CHALLENGES TO HIGH MEASLES VACCINE COVERAGE

1. The review of immunization services we conducted in PICTs highlighted some country-specific challenges to conducting high quality immunization services, including measles vaccines, but there were a number of common bottlenecks affecting many of the islands. The challenges that were widely relevant across the PICTs were identified through the extensive desk review and by additional input from professionals within WHO, UNICEF and World Bank who were based in the sub-region. These commonalities are discussed below.

Many of the challenges in immunization programmes related to deficiencies in the wider health system. Frequently, outreach activities were inadequate and were conducted on an *ad hoc* basis. The staffing of many health posts suffered from high turnover, absenteeism and the difficulty of retaining staff in remote areas.

Transport between the countries' many islands is mainly by ferry, outboard motorboat or canoe; there are limited and expensive inter-island flights. Various factors combine to

prevent or delay parents' visiting a clinic-brutal terrain reducing accessibility by remote populations, non-availability of transport, and travel logistics and costs [11]. Similarly, there is a wide range of population densities, with some countries (e.g. Kiribati) covering huge areas and having very isolated populations, while other islands contain dense urban populations, ideal for the transmission of measles.

PICTs are susceptible to climate change and extreme weather events including cyclones, floods and other disasters. These may disrupt regular services for months. The most recent and highest category cyclone to ever hit a PICT was in March 2015 when Vanuatu was hit by a category 5 cyclone, causing widespread destruction.

While national immunization programmes are funded to varying degrees from domestic resources, they rely extensively on external support. The costs of immunizing children will continue to rise for a number of reasons - increasing population, the introduction of more expensive new vaccines and the need to meet substantial increases in the vaccine bill in future. All PICTs face multiple burdens such as communicable and non-communicable diseases (NCDs), and continuing high fertility rates that place competing demands on the limited health budget. Because of their small size and limited ability to generate income from island resources, island governments struggle to keep up with ever-increasing costs, relying on donor support to make up the funding gaps, especially for emergency SIAs in the face of outbreaks. Measles syndromic surveillance (fever and rash) varied from active (weekly reporting of zero cases from sentinel sites) to passive reporting whereby only suspected cases were reported. Unfortunately passive reporting frequently equated to no reporting.

The capacity of the cold chain had been increased in many PICTs to accommodate increased storage requirements for new vaccine introduction, but there was an urgent need to refurbish much of the cold chain in PNG. The island environment tests even the most robust equipment. There has been a move towards solar power in more remote areas.

2. Purchasing power (the more purchased, the cheaper the price) for vaccine procurement and other supplies is markedly reduced by the relatively small quantities involved. Timely deliveries of vaccines are dependent on commercial carriers and weather, and delivery costs are high. While the Vaccine Independence Initiative (VII) enables thirteen countries to procure vaccines at affordable prices, the costs mount as the vaccine moves down the cold chain to the child [12]. Vaccines are all transported by airfreight from manufacturer to the Fiji central store. From there vaccines are moved to countries by air and then beyond to outlying islands (often by boat to remote communities). There is reliance on a monopoly air carrier, and vaccines are often off-loaded in favour of passengers or other expensive cargo. Inefficient quantification of vaccine needs can lead to multiple small orders and more freight costs. Most orders attract freight costs of around 20% of the cost of the vaccine, but it costs a much higher percentage for the more remote, smaller islands.

RISK OF OUTBREAKS

Certain factors suggest an on-going risk for measles outbreaks in PICTs. They include:

- Mediocre MCV coverage resulting in the accumulation of susceptible individuals
- Questionable quality of surveillance that may delay reporting of cases
- Dense urban populations facilitating transmission
- Extensive inter-island travel
- The risk of importations from larger neighbouring countries that continue to experience measles cases

Even for countries free of measles for some time, there is thus a danger of re-introduction and resurgence of the disease. Table (3) shows the number of confirmed measles cases in the previous 12 months in other countries in the Western Pacific Region – the Pacific Islands' nearest neighbours.

CONCLUSIONS

1. Despite significant progress, immunization programmes in PICTs face many challenges, and gains remain fragile. Most countries have achieved relatively high measles vaccine coverage but need to achieve and sustain very high coverage of each annual cohort of infants to prevent a build-up of unimmunized children and the risk of measles outbreaks. PICTs tend to experience a range of similar difficulties related to delivery of immunization services to remote, scarcely populated islands, and there are weaknesses in the health system that prevent provision of quality primary health care to all communities. Sustained high immunization coverage can only be achieved through an effective health system that can ensure quality of services at the coalface.

2. In line with global experience, there are indications of stagnation in routine coverage in recent years in some PICTs. Levels of national coverage and surveillance systems are not yet adequate to ensure countries remain measles-free in the event of importations of virus. If governments become more pressured from the mounting epidemics of NCDs, funding for immunization services may suffer as a consequence. The support of international stakeholders for measles control will remain essential for many PICTs for the foreseeable future.

LIMITATIONS

There are significant limitations to this study. Only three island countries were visited and these did not necessarily represent those with the lowest immunization rates. Each review was conducted over a period too short to allow for an in-depth review of the program. It is clearly impossible to fully understand or do justice to the range of complex issues facing the 22 countries of the Pacific, and findings from these brief visits have been extrapolated with caution.

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