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Review Article

Progress Towards Measles Elimination: Oman Experience

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Abstract

The Eastern Mediterranean region has set goals for interrupting indigenous transmission of measles using a strategy developed by the World Health Organization. This strategy includes recommendations for vaccination activities to be achieved and sustained thereby increasing the population's immunity. Measles epidemiological surveillance systems were developed to monitor illnesses characterized by febrile rash, and to provide effective virus detection and serological surveillance. Elimination is defined as the absence of endemic measles transmission in a defined geographical area (e.g., region or country) for ≥12 months in the presence of a well-performing surveillance system. Oman has committed to these goals.

Measles was a leading cause of infant and child morbidity and mortality in Oman before the introduction of measles vaccine by 1975 and thereafter until 1994. With the introduction of a second dose of measles vaccine in 1994, coverage for first and second doses of measles vaccine increased more than 95% in 1996 and has been sustained at a level greater than >95% since then. A national Measles and Rubella (MR) immunization catch-up campaign targeting children ages 15 months to 18 years was conducted in 1994 that achieved 94% coverage. As a result, the incidence of measles has declined markedly in recent years, to ≤ 1 case per million persons in 2012 and to zero cases in 2013.

Oman has made significant progress toward measles elimination and has met the regional elimination goals. However, new challenges faced by Oman, for instance with increased globalization, has led to issues such as outbreaks from imported cases. Additional challenges still remain with regard to increasing identification and immunization of unvaccinated non-Omani workers and their families.

Introduction

Oman is one of the twenty-two member countries in the World Health Organization (WHO) Eastern Mediterranean Region (EMR). It is located in the southeastern corner of the Arabian Peninsula with a coast that extends 3,165 kilometers from the Strait of Hormuz. Oman's borders include Yemen to the south, and the Kingdom of Saudi Arabia and United Arab Emirates to the west [Figure 1].

Oman had a total population of 3,992,893 in 2014. Nearly 44% of the population are non-Omani, and includes many resident workers and their families from south and southeast Asia. Children under 5 years of age comprise 9.5 % of the population, whereas those less than 15 years of age comprise 22% [1,2].

In 1997, the Regional Committee for the Eastern Mediterranean adopted a resolution for measles elimination reduction goals for the interruption of measles transmission in EMR countries by 2010 (EM/RC44/R.6) [3,4]. Based on WHO/EMR resolution measles elimination is defined as the absence of endemic measles transmission in a defined geographical area (e.g., region or country) for ≥12 months in the presence of a well-performing surveillance system. In 2011, due to the delay in achieving the measles elimination goals, the Regional Committee revised the goal date of measles elimination (EM/RC58/R.5) to 2015 [4,5].

The Region has witnessed commendable progress in measles control and elimination since establishing the regional elimination goals in 1997. Between 1998 and 2013 the number of reported measles cases decreased by 81% and by 2012, the measles mortality rate was significantly reduced by

Figure 1: Map of Oman.

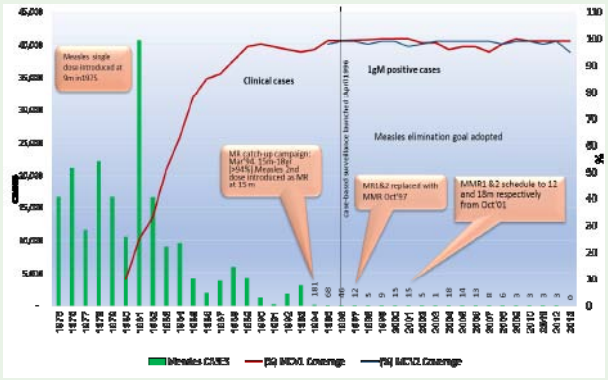

Figure 2: Measles incidence and vaccination coverage (MCV1 and MCV2), Oman, 1975-2013.

89% [6]. Measles national case-based laboratory surveillance is being implemented in all countries. By 2014, 6 countries reported very low incidence of measles, two reported zero endemic cases and are ready to verify measles elimination and countries with lower vaccination coverage continue to implement supplementary activities to boost population immunity. Member States should extend progress to date and intensify efforts to accelerate advancement towards achieving and sustaining measles elimination in accordance with the Regional Committee goals [3].

Measles has been a significant cause of infant and young child morbidity and mortality in Oman. During 1975-1982 more than 10,000 measles cases occurred annually with a mortality rate of approximately 20-30%. The first monovalent Measles Containing Vaccine (MCV1) was introduced into EPI in 1975. In 1996, the Ministry of Health (MOH) developed a national plan for measles elimination that included a revised measles immunization schedule, introduction of case-based surveillance, and annual immunization campaigns of school children. As vaccine coverage increased above 95% (1999-2013) fewer measles cases occurred from a mean of <1000 cases annually during 1990-1996 with a mean of 7 cases annually during 1997-2006 [7]. From 2007 onward, only 5 cases or less were reported. Subsequently, Oman adopted the WHO/EMR resolution for measles elimination by 2010 [3] and revised the goal date by 2015. Further, Oman has established an independent measles technical expert committee to review the status of measles elimination. This committee's advice on corrective actions will be critical for achieving and maintaining successful elimination. In this report, we describe the progress made towards measles elimination and the challenges ahead to achieve and maintain elimination in Oman.

Methods

Vaccination strategy

The Expanded Program on Immunization (EPI) in Oman was launched in 1980. Further, EPI has been integrated into the Primary Health Care (PHC) services provided by the MOH. Since then, numerous efforts have been made to ensure the expansion of MCV1 and MCV2 at the grass roots level.

All measles-related activities, including both immunization and laboratory testing of suspected measles cases, are financially supported by the government and provided free of charge in government health facilities for all Omanis and non-Omani residents. Immunizations for measles and other diseases are provided in all primary health care centers and in certified vaccination units at private health facilities. To receive immunization and primary care, each infant and child in Oman is registered with a specific health facility, either at birth or on entry into the country, based on residential address and using a unique identification number. Parents are given immunization cards for their children, and these cards are updated at each immunization clinic visit. Health facilities also maintain the following information: A hard copy of the registration databases for their catchment population, childhood screening booklets for each infant and preschool child containing information on immunizations and screening findings.

A unique defaulter retrieval system was also introduced to complement the programme. Parents of any child who missed, the vaccination appointment will be called by the EPI staff nurse. If there is no response from the parents for more than two weeks, a home visit will be done by a public health sanitarian [7]. Healthcare workers at primary health centers and school health nurses are advised to trace Measles-Mumps-Rubella (MMR) immunization defaulters. Vaccination is provided if there is no documented evidence of measles (MCV1 and MCV2) vaccination among school children.

Furthermore, by 1994, the Ministry of Health had established a policy that required proof of completion of all routine immunizations, including 2 doses of MR or MMR vaccine, for any eligible person and for primary school entry at any level. Children or any eligible person with incomplete or unknown vaccination status is required to complete their childhood recommended immunization schedule. Children are not excluded from schools however, as education is considered a right for all citizens and residents.

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The national primary vaccine store became the first store to meet the new WHO/UNICEF criteria of Effective Vaccine Store Management (EVSM) [7]. It includes a built-in efficient internal supervision and monitoring system, proper storage and handling of vaccines established at all governors and regular external reviews by WHO/UNICEF. In addition, guidelines are being developed to govern the vaccine handling safety process.

Vaccination coverage

All health facilities send the vaccination coverage data monthly to the Immunization Unit at the Department of Communicable Disease Control (DCD&C), MOH. Measles immunization coverage is calculated using the number of doses of MMR administered as the numerator, and the number of surviving infants or the number of infants and children registered at health facilities as the denominator. Data on measles immunization coverage and other vaccination statistics are analyzed at both districts and national levels, and feedback is sent to all health facilities and concerned health authorities on a monthly basis [8,9]. In addition, the administrative coverage is confirmed by periodic validation of the vaccination coverage data using Data Quality Self-Assessment (DQS) every 3 years and coverage evaluation surveys every 5 years.

Disease surveillance

The national communicable disease surveillance 'system' was formally launched in Oman in March 1991 to be in conformity with the 'communicable disease law' issued by royal and ministerial decrees. The Department of Communicable Disease Control functions as the apex body. The surveillance system ensures the collection and use of appropriate and timely data for dealing with the target priority diseases including emerging and re-emerging infections. The priority communicable diseases are grouped into 'A', 'B' and 'C' based on the urgency of reporting and the response. The regrouping of measles was done in 1996 by shifting from Group 'B' to 'A' since the launching of the elimination initiative in the same year. Regional epidemiologists are assigned at all governors to oversee the surveillance activities [7].

Measles notification is integrated into the national communicable diseases surveillance system and is in place nationally and monitors measles incidence, mortality and other notifiable vaccine-preventable diseases. The MOH requires all health facilities, including private establishments, to notify suspect measles cases within 24 hours of suspicion to the governorate Communicable Diseases Surveillance Control Unit (CDSU). Reporting must be done in a timely manner, including zero reporting of measles from all institutions. The MOH periodically sends communications out to all doctors reminding them about the requirement for timely and zero reporting of measles.

A "fever and rash" illness surveillance activity was launched in the late 2004 throughout the country. The fever and rash case definition included any individual of any age who developed sudden onset of fever and rash (excluding chickenpox). These cases would be considered as a "suspected case of fever and rash illness syndrome" and would be subjected to measles and rubella IgM antibody testing simultaneously based on an algorithm [Figure 3]. In addition, fever and rash illness weekly zero reporting from the entire country was established in addition, the existing infrastructure for acute flaccid paralysis and neonatal tetanus surveillance was also utilized for this purpose.

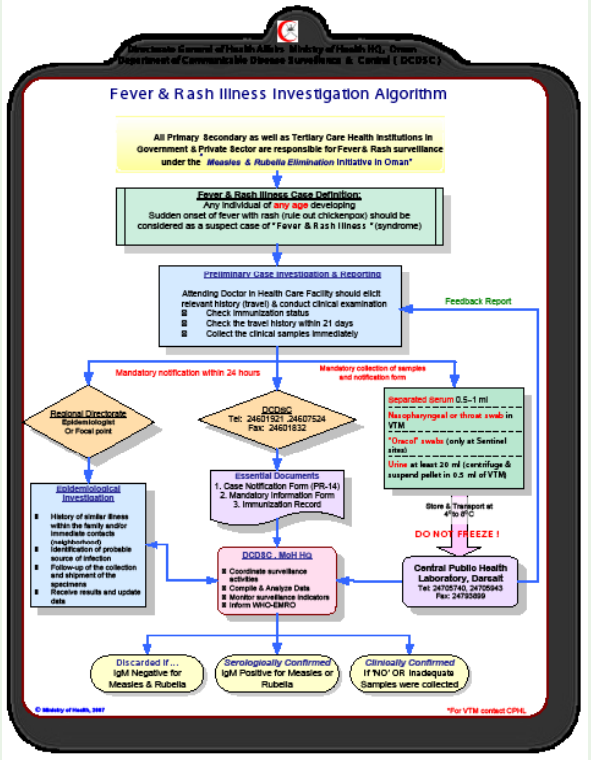

Figure 3: Fever and rash illness Investigation algorithm.

Measles IgM antibodies are tested by Enzyme-Linked Immune Sorbent Assay (ELISA) at the Oman's Central Public Health Laboratory (CPHL), a WHO Accredited Regional Reference Laboratory for measles and Rubella viruses. Since 2005, all specimens from IgM-positive cases undergo Polymerase Chain Reaction (PCR) confirmation and genotyping. Viral culture and isolation are performed from throat/nasal and urine samples collected from all fever and rash illness cases for the purpose of viral typing. Oman's CPHL is part of the World Health Organization (WHO) Measles Laboratory Network (MRLN) and all measles laboratories confirmed cases from designated National Measles and Rubella laboratories are forwarded to CPHLfor validation and genotyping. The Central Public Health Laboratory performed genotyping of measles virus for the past 2 decades.

Outbreaks

As per the national policy an outbreak is defined as the occurrence of one clinically suspected or confirmed measles case [10,11] and warrants immediate initiation of outbreak control activities. According to the national guidelines for measles surveillance, all outbreaks should be investigated within 48 hours. Clinical specimens should be obtained from all persons with suspected cases and sent to the Central Public Health Lab within 3 days. In addition, children 1 year and above and adults are checked for their previous vaccination history. If there exists no evidence of vaccination, vaccination is provided to all contacts of suspected cases.

All outbreaks of measles are investigated with particular reference to age, vaccination status and history of travel. Attempts are made to find the index case and data are analysed for programme evaluation.

Results

Vaccination coverage

In 1975, the first dose of monovalent measles immunization, MCV1 was introduced into EPI to children 9 months of age. The proportion of young children who were immunized rose from approximately 10% to 95% during 1980 to 1993 [Figure 2]. In 1994, the first dose of measles (MCV1) at 9 months was replaced by measles-rubella (MR-1) and the second dose (MR-2) introduced at 15 months. Coverage for both MCV1 and MCV2 has been sustained at ≥ 97% nationally and provincially since 1994. The administrative coverage has been confirmed by coverage evaluation surveys conducted in 2008 and the results were consistent with the administrative coverage in the country [12].

During October 1997, the first and second doses of measles and rubella (MR1 and MR2) vaccine were replaced by the Measles-Mumps–Rubella (MMR) vaccine. In line with the measles elimination strategy, in October of 2001 the first dose (MMR1) and second dose (MMR2) were rescheduled to be given at 12 and 18 months respectively [Figure 2].

Campaigns

In response to widespread outbreaks of measles and rubella cases in 1993-1994, a nationwide catch-up campaign was conducted in 1994 using the MR vaccine, targeted children aged 15 months-18 years and attained 94% coverage. A marked decline of measles cases was observed following this campaign [Figure 2]. After this campaign, the Ministry of Health began estimating the number of unvaccinated children annually to predict the risk of outbreaks and to determine the need for national measles campaigns. Further Supplemental immunization activities are conducted regularly in response to any confirmed measles case to ensure high coverage of 2 doses MMR for persons in areas near confirmed cases.

To help achieve the measles elimination goals, a catch-up MMR immunization campaign was done in 2007 targeting 9933 non-national students ages 15-18 years in several private schools in Muscat governorate and achieved 99.6% coverage. Further annual estimation of measles-susceptible children among successive birth cohorts based on the number of unvaccinated children in each cohort is being done. It was determined that <5% of the population is susceptible to measles and that nationwide follow-up campaigns were not needed.

Disease surveillance

Since the introduction of measles vaccine (MCV1) in 1975, the incidence of measles has fallen from between 45-52 cases per 100,000 population from 1975 to 1984, and further to 25-38 cases per 100,000 population from 1985-1993. After the catch-up campaign in 1994, measles incidence has decreased sharply to 0-4.5 cases per 100,000 [Figure 2].

Table 2: Epidemiology of Laboratory Confirmed Measles Cases-Oman, 2010-2013.

Characteristics	2010-2013	
	N	%
<1	6	55
1-4	0	0
5-9	0	0
10-19	3	27
20-29	1	9
>30	1	9
Sex		
Male	5	45
Female	6	55
Muscat	3	27
Dhofar	4	36
Dakhilya	1	9
N. Sharqiya	-	-
S. Sharqiya	1	9
N. Batinah	1	9
S. Batinah	1	9
Dhahira	-	-
Buraimi	-	-
Musandum	-	-
Wusta	-	-
Nationality		
Omani	8	73
Non-Omani	3	27
Unknown	4	36
Ineligible (age <1y)	6	55
Unknown	0	0
Total	11	

Table 1: Measles Surveillance indicators and Measles Cases-Oman, 2000-2013.

Surveillance indicators & Cases Investigated	WHO Criteria/ Targets	Year													
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Suspected measles cases reported (n)	NA	68	58	41	18	723	667	700	746	866	595	459	793	696	699
Cases measles IgM positive (n) (Classified by the TMEC**)	NA	15	15	5	1	18	14	13	8	6	3	3	3	3	0
Non-measles, non- rubella cases (n)	NA	53	43	39	17	705	653	687	738	860	592	456	788	693	699
Incidence of confirmed endemic measles case per million per year population	Zero	6.5	6	2	0.4	7.4	5.6	5	3	2	0.9	1	0.8	0.8	0
Sites reporting weekly or monthly (%)	NA	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Non measles, suspected measles reporting rate per 100,000 population	≥2	2.8	2.3	1.6	0.8	29.9	26.6	27.2	27.2	29.7	18.7	14.2	22.5	19.2	24.5
Suspected cases reported<48h from onset (%)	≥80%	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cases investigated <48h after notification (%)	≥80%	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cases with adequate specimens collected (%)	≥80%	100	100	98	94	99	98	98	98	99	97	96	98	99	99
Specimens received by laboratory <5 days (%)	≥80%	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Laboratory results reported<7 days (%)	≥80%	*	*	*	*	*	*	100	100	100	100	100	97	100	100
Sufficient samples collected for virus detection in a proficient laboratory from 80% of identified transmission chains (outbreaks).	≥80%	*	*	*	*	*	*	96	97.6	98	99.7	98.2	98.8	98.5	89.6

Since 1995, there were 34 outbreaks involving 45 cases. These outbreaks were reported from mainly South Sharqiya, Muscat, and South Batina governorates. Forty-three percent of cases were imported. Fifty-eight percent were reported for the private non-Omani residents' schools in Muscat governorate and 36% were among children less than 1 year of age. Nearly all of the cases (92%) were unvaccinated.

Surveillance indicators have been monitored since the introduction of case-based surveillance in 1996 nationally and provincially [Table 1]. During 2004-2013, the suspect measles reporting rate has ranged from 0.8 to 30 cases per 100,000 persons, and the timeliness of reporting and investigation of suspect cases have generally been above 95%. All persons with suspected cases investigated have had clinical specimens collected, and transport of specimens to and testing by the national measles laboratory have been prompt (> 95% and > 95% within 7 days, respectively).

During 2004–2013, 73 laboratories confirmed measles cases were identified and classified as endemic measles cases by the measles national expert committee [Table 1]. Of the 11 confirmed cases identified during 2010-2013, most of them (55%) were below 1 year of age. Half were females, 73% were Omanis and 36% of the case-patients lived in Dhofar Governorate. The measles vaccination status of 36% was unknown and 55% were too young for measles vaccine administration [Table 2].

Virus isolation and Genotyping

The CPHL has performed genotyping studies on measles virus during the previous 2 decades: the endemic genotype of measles virus in Oman cases during 2010-2013 were sporadic cases and had genotypes D4 and D8 related to importation from southeast Asia. B3 genotype was also identified from Dhofar governorate in two cases.

Discussion

By 2013, Oman has made great progress towards measles elimination goals by implementing two main strategies [13,14]: achieving and sustaining high immunization coverage and maintaining high population immunity, sensitivity of the surveillance system, and hence low measles incidence.

The first strategy of sustaining high immunization coverage has been achieved through high routine immunization coverage (MMR1 and MMR2), reaching > 97 % coverage nationally and provincially, and through catch-up immunization campaigns conducted in 1994. In addition, a school-based catch-up immunization campaign was conducted in 2007 in Muscat governorate with 99.6% coverage. Furthermore, supplemental immunization activities are conducted regularly in response to any confirmed measles case to ensure high coverage of 2 doses MMR for persons in areas near confirmed cases.

The annual estimate of the measles susceptible cohort has remained far below 5% and therefore a nationwide follow-up measles immunization campaign was not required during the last decade. All these immunization activities have contributed to high immunization coverage and the population immunity to measles.

The second strategy, developing sensitive case-based surveillance for measles, was implemented in 1996. Over the last decade, Oman has achieved all the targeted measles surveillance performance indicators for the elimination phase and all have exceeded the WHO criteria shown [Table 1]. WHO EMR Member States adopted a background rate of 2 suspected non-measles cases per 100,000 population as the indicator of surveillance system sensitivity to detect measles transmission in a highly vaccinated population, on the basis of global experience with measles surveillance. In this regard, Oman achieved and maintained a very high rate over the years. The achievement of timely and sensitive measles surveillance in Oman is the outcome of the collaboration between the EPI unit, the governorate surveillance units, and the central public health laboratory. In addition, the central public health laboratory is annually validated, has been accredited by the WHO since 2000 and the proficiency panel test results have always been 100%.

The progress made in Oman towards measles elimination has been facilitated by strong political commitment across the country, marked an achievement in measles immunization coverage (>98%) both nationally and provincially, well-trained governorate EPI and epidemiologist health care workers across the country, and free vaccination services to all residents. But, the absence of policy that requires measles vaccination for expatriates to work or visa permit presents a challenge in a country where nearly 44% of the non-Omani population.

As a result of the 2 main strategies and all the enabling factors described previously, measles incidence in Oman has reached record low levels during the preceding decade. The average annual number of cases has declined by 99% since the 1975s. All confirmed cases have recovered fully and there have been no deaths attributed to measles during the last decade. The incidence of measles has declined to zero cases per million persons in 2013.

In 1997, the Regional Committee for the Eastern Mediterranean Region adopted a resolution for measles elimination reduction goals for interrupting transmission of measles in countries of the EMR by 2010. To reach this goal, WHO/EMRO has developed a series of 5-year plans based on the WHO-UNICEF joint plan for measles elimination. In 2011, due to the delay in achieving the measles elimination target, the Regional Committee for the Eastern Mediterranean decided to revise the target date of measles elimination to 2015 [14].

Oman has been engaged in measles elimination since 1996, and has implemented WHO-recommended strategies for immunization activities and coverage, case-based surveillance, and clinical care, with great success. Despite the challenges of measles virus importation and improving population immunity to measles in residence non-Omani workers and their families, Oman is on track to sustain the measles elimination in the near future.

Oman has met the elimination goals and verification will follow in 2017, after three years of confirmed interrupted endemic measles virus transmission. Elimination of measles will depend largely on obtaining political commitment, achieving high coverage and closing immunity gaps and ensuring high-quality, case-based surveillance throughout.

Building on its remarkable success of the polio eradication programme with interruption of wild poliovirus circulation since 1993 [7], Oman has fully committed to the regional elimination goal and appears to have achieved measles elimination that is, interruption of endemic measles virus transmission, based on the sensitivity of the surveillance system, low incidence of confirmed disease (zero case per million), and limited transmission after detection of a confirmed case.

Measles elimination is facing a number of challenges, including a high population of non-Omani residence workers and their families (44%) out of which 92% are above an age of 20 years [2]. This population frequently travels in and out of high measles endemic countries and many are unvaccinated or not fully vaccinated. In order to facilitate reducing the immunity gap, the MOH should request of this population evidence of receiving 2 MCV vaccines. In addition, a large population is entering Oman with visiting visas (i.e., short term visit up to 3 months). There are currently no vaccination requirements for persons with visiting visas. Additionally, regulating unrestricted cross border movement in Oman of unvaccinated adults and children from some countries is a challenge that should be addressed.

Conclusion

To sustain this achievement, Oman will need to maintain population immunity to measles; maintain and improve surveillance system sensitivity for measles, include identification of measles virus genotypes; and continue to conduct prompt investigation and response to measles cases and case-clusters. In addition, high-risk areas with concentrations of resident non-national workers from countries where measles is endemic should be identified and Oman must identify the immunization gaps, and conduct targeted immunization activities in these communities. Establishment of an independent verification committee to review the status of measles elimination and provide advice on corrective actions will be critical to achieving and maintaining successful elimination.

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