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MEASLES OUTBREAK INVESTIGATION IN VILLAGE PIPALIYA HASNABAD AND ADJOINING VILLAGES, BERASIA BLOCK, BHOPAL DISTRICT, MADHYA PRADESH, INDIA, JULY- AUGUST 2023

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Abstract

Background

India has adopted measles–rubella (MR) elimination goals; however, three laboratory-confirmed measles cases were reported from Berasia block, Bhopal district, in August 2023, in an area known for vaccine hesitancy. No measles outbreaks had been reported in Bhopal during 2020–2022. We investigated this outbreak to describe its epidemiological characteristics and identify root causes.

Methods: We defined a suspected case as fever with maculopapular rash in any resident of Pipaliya Hasnabad or adjoining villages, Berasia block, between 28 April and 28 August 2023. A confirmed case was defined as measles-specific IgM positivity by ELISA. Epidemiologically linked (epi-linked) cases were those occurring from outbreak declaration up to 12 weeks, and within 4 weeks of onset of the last case. Active case search was conducted through house-to-house visits. Cases were interviewed using a semi-structured questionnaire and standard D003 form. Root-cause analysis included review of surveillance performance, routine immunization coverage, immunity gaps, and outbreak response activities.

Results: We detected 36 measles cases (6 laboratory-confirmed, 30 epi-linked); median age was 60 months (IQR 33–90), 44% were female, and 97% belonged to the Muslim community. Most cases occurred in children aged 5–9 years (39%) and 1–4 years (33%). In addition to fever and rash, common symptoms were coryza (42%), cough (39%), and conjunctivitis (19%); complications included acute respiratory illness (42%), diarrhoea (19%), and malnutrition (8%). The overall attack rate was 0.57% with no deaths, and 92% of cases were unvaccinated or partially vaccinated. An immunity gap for MCV2 (coverage <95% at district and block level during 2021–2023) persisted despite reported MCV1 coverage >95%. Awareness gaps (16% at district and 40% at block level) and vaccine hesitancy related to AEFI concerns and refusals (54% and 47%, respectively) were prominent, although timeliness indicators and routine immunization/surveillance performance were largely within recommended standards.

Conclusion: This laboratory-confirmed measles outbreak in Pipaliya Hasnabad primarily affected 1–10-year-old children from a predominantly Muslim community. Despite overall satisfactory routine immunization and surveillance performance, an MCV2 immunity gap, coupled with substantial awareness deficits and vaccine hesitancy, contributed to the accumulation of susceptible children and subsequent outbreak. Strengthening MCV2 coverage and targeted risk communication to address hesitancy are critical to sustaining MR elimination efforts

Keywords: Measles, Elimination, Disease outbreaks, Vaccination, India

INTRODUCTION

Measles is a highly contagious disease caused by the paramyxovirus (RNA), genus morbillivirus. The route of transmission of measles is by droplet infection, droplet nuclei.(1) The incubation period of measles is around 10-14 days. Measles is highly communicable, with more than 90% secondary attack rates among exposed susceptible persons in close-contact settings. Measles is considered transmissible from 4 days before through 4 days after rash onset.(2) Measles has case fatality rate of > 10 % in endemic areas. Clinically measles infection is characterized by fever, maculopapular rash and koplik's spot followed by starts from behind the ear and spreads in all over body in period of 3-4 days and may have complication as diarrhea, acute respiratory infection, pneumonia, otitis media, encephalitis, and rarely sub-acute sclerosing pan encephalitis.(2) An estimated 136 000 people died from measles in 2022 – mostly children under the age of five years. Accelerated immunization activities successfully prevented an estimated 57 million deaths between 2000–2022.(3) India targeting to eliminate Measles till 2023. Total cases of Measle increased from 43247 to 61461 from 2022 to 2023*(November 2023). Per million incidence rate of Madhya Pradesh was increased from 5.4 from Dec 2021 to Nov 2022 to 23.5 from Dec 2022 to Nov 2023. (4)

There was no measles outbreak in district Bhopal since 2021-2023.(5)The laboratory confirmed measles cases were reported from village Pipaliya Hasnabad block Berasiya, district Bhopal, Madhya Pradesh India, which is known areas for vaccine hesitancy, on dated 9 August 2023. Preliminary search, on dated 11th August 2023, suggest more cases in and around the village Pipaliya Hasnabad including nearby Tapra (Nomadic site). So, the outbreak was flagged on dated 14

August 2023 and investigated by AEP officer with objective of describing epidemiology of outbreak, elicit root cause of outbreak by evaluating surveillance system , routine immunization system, coverage assessment, and timeliness of response to outbreak and provide the evidence-based recommendation for controlling the outbreak, and prevent outbreak in future.

METHODOLOGY

We have used case definition of suspected Measles cases as 'A case of fever with maculopapular rash in a person of any age from 28th April till 28th August 2023 and is resident of village Pipaliya Hasnabad, Khejada Gopi and adjoining areas of block Berasia district Bhopal' , definition of c A suspected case with detection of measles specific IgM by ELISA or measles antigen by polymerase chain reaction as any suspected case from 28th April till 28th August 2023 and is resident of village Pipaliya Hasnabad, Khejada Gopi and adjoining areas of block Berasia district Bhopal, confirmed Measles cases as 'A suspected case with detection of measles specific IgM by ELISA or measles antigen by polymerase chain reaction as any suspected case from 28th April till 28th August 2023 and is resident of village Pipaliya Hasnabad, Khejada Gopi and adjoining areas of block Berasia district Bhopal'.(6) The lab confirmation of IgM measles was done at 'State virology laboratory, Gandhi Medical college, Bhopal', which is WHO accredited laboratory for eastern region of Madhya Pradesh.

Epi-link cases of Measles defined as "Additional suspected cases during last 12 weeks up to ≤4 weeks of from the date of onset of last case of this lab-confirmed outbreak but without specimens collected." The definition of outbreak of Measles is number of Fever rash cases > 5 in block in 4 weeks period or 1 measles death cases in block" (6)

Case search was carried out by formation and training 22 teams consist of ASHA (Accredited social health activist), AWW (Aaganwadi worker), ANM (Auxiliary Nursing Midwifery), MPW (Multi-purpose worker), Health supervisors, ASHA supervisors. The training done on dated 17th August 23. The survey completed from 18th August to 26th August 23 under supervisions of Health supervisors, sector medical officer, Block Medical officer (BMO), District Immunization officer (DIO) and AEP officer. Total areas covered were villages Pipaliya Hasnabad, nearby Tapra, Khejada Gopi, ward 7&17 of Berasia Urban of block Berasia, District Bhopal, Madhya Pradesh, India. Total survey conducted for population of 6291. Passive surveillance conducted through sensitization of doctor of Community Health Centers (CHC) of Berasia, desk review of IDSP report in 'S' form for duration of June 2023- August 2023. The data collection tool for survey used was standard for "OB003" as well as semi-structured questionnaire. (Annexure 1) the data collection tool captures the variables clinical history of patient, travel history, vaccination status, reasons for partial vaccination, health seeking behavior, socio demographic factors.

Root cause analysis done to find out Surveillance gap, Routine immunization system gap, Immunity gap, outbreak response gaps(7) through selected indicator as below and comparison done for three-year data at district and block level. Indicators used for assessment of surveillance gaps with criteria for classification of Indicators were NMNR rate (Good: ≥ 2, Moderate: 1.0 -1.9, Poor: < 1), Proportion of cases investigated within 48 hours, Proportion of cases with adequate serological samples collected, Proportion of cases sample received in lab within five days of collection, Proportion of reporting units submitting weekly reports in last 6 months, Proportion of district weekly review (DWR) meetings conducted in last 6 months (Good: ≥ 80%, Moderate: 60-79%, Poor: < 60%). Indicators used for assessment of routine immunization system gaps with criteria for classification of Indicators were Presence of District immunization officer at district level and medical officers, ANM (Auxiliary Nursing Midwifery), at district and block level (Good: ≥ 80%, Moderate: 60-79%, Poor: < 60%). Availability of micro plan and updating yearly. Indicators used for assessment of outbreak response gaps with criteria for classification of Indicators were Proportion of flagged outbreaks with preliminary search done (Good: ≥ 80%, Moderate: 60-79%, Poor: < 60%), Median days between flagging of outbreak to prelim search, Median days Flagging outbreak to detail Investigation, Median days detail Investigation to sample collection (Good: <3 days, moderate: 3-5 days, Poor: >5 days), Median days from preliminary search to Detail Investigation (Good: <2 days, moderate: 2-5 days, Poor: >5 days), Median days from First case rash onset to Index case notification (Good: <7 days, moderate: 7-14 days, Poor: >14 days). Indicators used for assessment of immunity gaps with criteria for classification of Indicators were HMIS coverage data of MCV 1 and MCV 2 Vaccine, WHO RI monitoring data of MCV1 (12-59 months), and MCV 2 (23-59 months) (Good: ≥ 95%, Moderate: 80-95%, Poor: < 80%). Indicators used for assessment of reason for missed vaccination gap in awareness for RI among community, operational gaps, adverse event following immunization apprehension, refusal families.

Data collected tool: - The case information was collected by Medical officer in standard case investigation form (CIF) (annexure 1), for those cases sent for laboratory confirmation and OB003 (annexure 2) form for epi-link cases, by FLWs trained by AEP officer as per standard operating procedure from ministry health and family welfare guideline for Measles rubella surveillance.(8)

The desk review was done for hospital records as well as IDSP reports to find additional cases by AEP officer. Desk review done for indicators and HMIS data available at DIO office Bhopal.

Output analyzed by Microsoft excel tool version 2208.

Ethical approval has been exempted by government of India as this is an emergency.

Results

As per figure 1, the affected villages were Pipaliya Hasnabad and nearby Tapra, Khejada Gopi and ward 7 and 17 of Berasia town (urban areas) spread over 5-kilometer areas.

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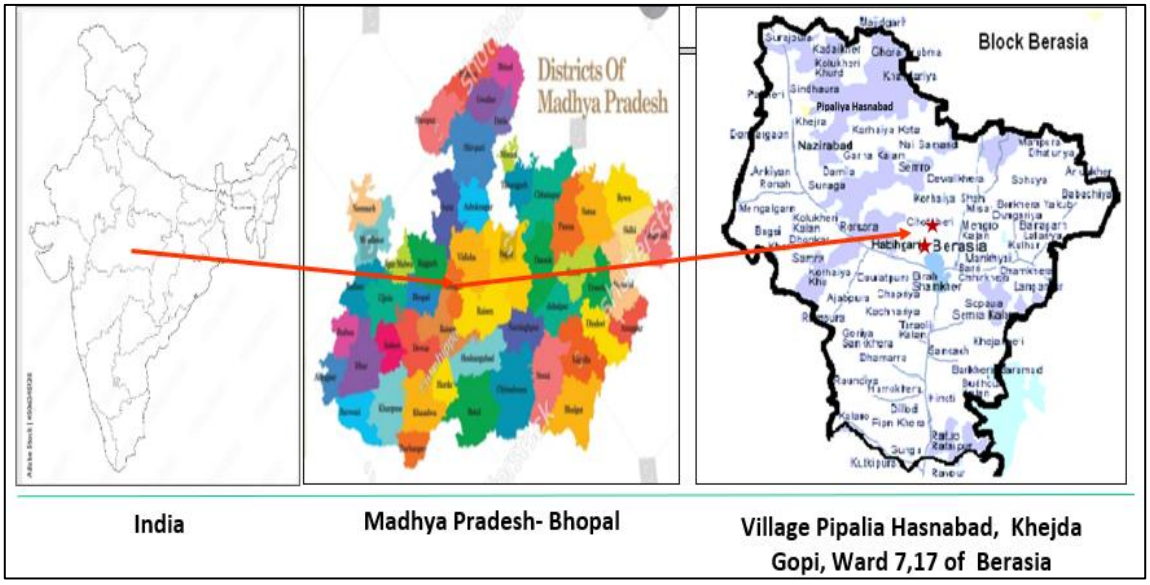

Figure 1 :- **Geographical location of Measles outbreak in village Pipaliya Hasnabad, Berasia, block, Bhopal district, Madhya Pradesh, India, July- August 2023**

As per figure 2, the measles outbreak had 36 cases occurred with 6 laboratory confirmed Measles cases and 30 epi-link cases identified. Outbreak continued for 40 days around from 17th July to 26Th August. Index case reported on 20th July and first laboratory positive case date of onset is 28th July all by ASHA supervisor (Frontline worker of the same village) and investigated by sector Medical officer. The preliminary search started on 11th August after receipt of lab reports on 9th August and flagging of outbreak done on 14th August 2023.

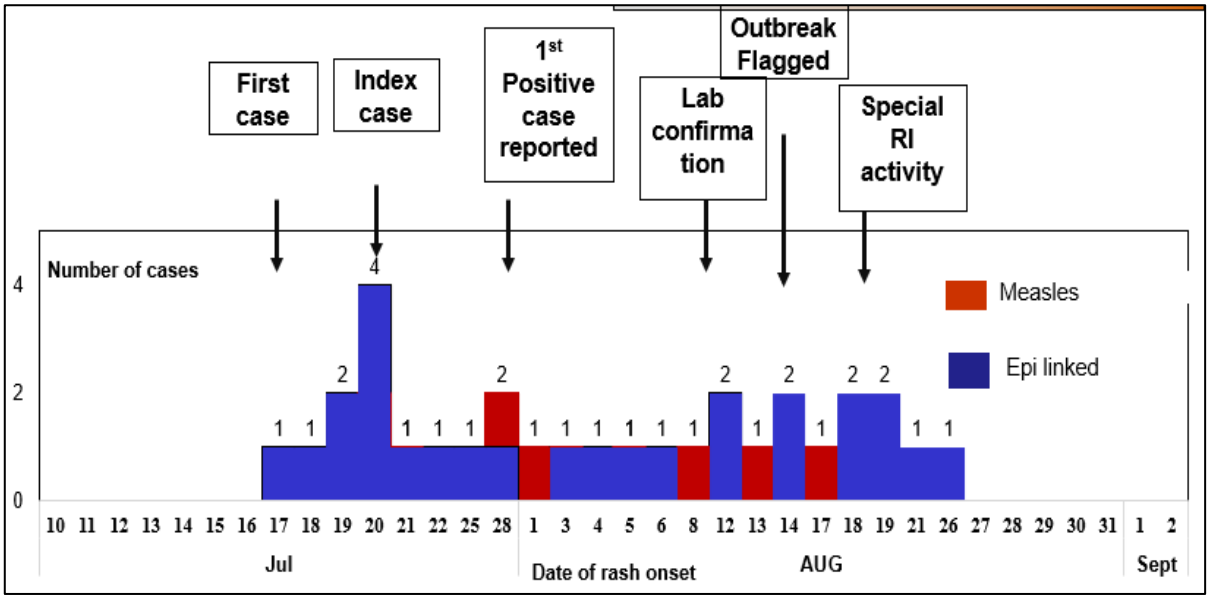

Figure 2: - Epi-curve and timeline of events of Measles outbreak in village Pipaliya

Hasnabad, Berasia, block, Bhopal district, Madhya Pradesh, India, July- August 20203

As per table1, the median age of the affected children were 60 months with interquartile range 33 months to 90 months. The most common affected age group was 5years to <10 Years 14(39%) followed by 1year to <5 year 12(33%). There were 16 (44%) females affected. 35(97%) of the children belong to Muslim religion. Commonest affected age group was 5years to 9 years 14(39%), followed by 1year to 4 years 12(33%) then 10 years to 14 years 8(22%). Among the affected children 23(64%) children do not receive any measles containing vaccine while 10(28%) children received single dose. Apart from fever and rash 15(42%) cases had Coryza, 14(29%) had Cough and 7(19%) had conjunctivitis. Out of 36 affected children 15(42%) had complication in the form of acute respiratory infections, 7(19%) had diarrhea, and 3(8%) children had malnutrition. The total affected population were 6292 and attack rate was 0.57% although no death reported during this outbreak. All the affected children received the 2 doses of Vitamin A supplementation.

Table 1: Description of Measles outbreak in village Pipaliya Hasnabad, Berasia block, Bhopal district, Madhya Pradesh, India, 2023

Characteristic	Total Positive cases, N= 36 n (%)
Age Group	
< 9 Months	*0(0%)*
9 months- <1 year	*2 (6%)*
1 Year- <5 Years	*12 (33%)*
5 Years - <10 Years	*14 (39%)*
10 Years – <15 Years	*8 (22%)*
>15 Years	*0(0%)*
Mean Age Group	*60 months*
Interquartile range	*30 months – 90 months*
Gender	
Male	*20 (56%)*
Female	*16 (44%)*
Religion	
Hindu	*1 (3%)*
Muslim	*35 (97%)*
Vaccination Status	
Zero MCV doses	*23 (64%)*
One MCV doses	*10 (28%)*
Two MCV doses	*3 (8%)*
Clinical Symptoms	
Fever	*36 (100%)*
Rash	*36 (100%)*
Cough	*14 (39%)*
Coryza	*15 (42%)*
Conjunctivitis	*7 (19%)*
Complications	
Diarrhea	*7 (19%)*
Acute Respiratory Infection	*15 (42%)*
Malnutrition	*3 (8%)*
Population of affected areas	*6292*
Attack rate	*0.57%*
Deaths	*0 (0%)*
Vitamin A Supplementation	*36 (100%)*

As per table 2, routine immunization system assessment was good in term of DIO presence, filled position of ANM (85%) and MO (86%) and yearly updating RI micro-plan. Surveillance system assessment were also good as Non-Measle, Non-Rubella (NMNR) discard rate was above 2 per lacks population at district and block since last two years. The indicators 'Proportion of cases investigated within 48 hours of notification, Proportion of cases investigated within 48 hours, Proportion of cases with adequate samples, and the samples received in lab within five days' were also above 80% at district and block level since last three years. Weekly submission of reports in last 6 months of was 100% for district. The district weekly review meeting conducted during past 6 months was 38%.

MCV 1 coverage was above 95% at district and block level since last three years but MCV2 coverage which was in between 85 to 95 % as per HMIS data. The WHO Monitoring data also had coverage of MCV 1 above 95% in year 2023 at district and block level. The Monitoring data of MCV 2 coverage was in between 80-94 % at district and block level. Major reasons for low coverage were awareness gap 16% at district and 40% at block level as well as Vaccine hesitancy in term of AEFI apprehension and refusal families was 54% at district and 47% at Block level.

The outbreak response was categorized as good for 'detection of case, median days of preliminary search, flagging outbreak and sample collection", Moderate for "median days of flagging outbreak to detail investigation' but poor for 'median days for preliminary search to detail investigation'.

DISCUSSION: -

The current study showed the attack rate of 0.57% with no death. The previous study reported very high attack rate and case fatality Rate. (9–14) The possible reason was good coverage of MCV1 and MCV at district and Block level. Most of the cases were below 15 years (78%) with commonest age affected age group 5-10 years (39%). Previous study also showed the similar finding(9), (10) but many documented different age group for measle infection.(11–13) The males were affected more (56%) which was also similar to previous studies. (11,15) Our study reveals that majority of children had not received the Measles vaccine (64%) or single dose of vaccine (28%) showing major immunity gaps to prevent from measles disease. Previous studies also revealed that poor vaccine coverage was major cause for measles outbreak. (9,13,14) The common symptoms besides fever and rash were cough (39%), coryza (42%) and conjunctivitis (19%) which are also mentioned in refence document of measles disease.(1,2,16) this investigation reported Acute respiratory infection(42% as commonest complication followed by diarrhea (19%) and Malnutrition (8%) which was different from previous studies where diarrhea was common followed by pneumonia and otitis media.(13,15). This finding may be due early administration of two doses of Vitamin A to all children which has protective effect in developing severe complication and death.(17)

Surveillance System assessment	**Data for last 3 yrs.**				**Criteria**	**Assessment**
Non measles non rubella discard rate (Total discarded cases/ total population) *100000	Year	2021	2022	2023	Good: ≥ 2 Moderate: 1.0 -1.9 Poor: < 1	**Good**
	District-Bhopal	2.5	5.5	11.42		
	Block-Berasia	1.13	7.94	2.09		
Proportion of cases investigated within 48 hours of notification (Cases investigated within 48 hours of notification/Total cases reported)	District – Bhopal	87	97	93	Good: ≥ 2 Moderate: 1.0 -1.9 Poor: < 1	**Good**
	Block-Berasia	100	100	94		
Proportion of cases adequate serology samples collected (Cases adequate serology sample collected/Total cases reported)	District – Bhopal	76	96	99.7	Good: ≥ 2 Moderate: 1.0 -1.9 Poor: < 1	**Good**
	Block-Berasia	75	100	100		
Proportion of cases sample received in lab within five days of collection (Samples received in lab within five days of collection /Total samples collected)	District – Bhopal	93	99	93	Good: ≥80% Moderate: 60-79 Poor:<60	**Good**
	Block-Berasia	75	100	94		
Proportion of reporting units submitting weekly reports in last 6 months	**Data for last 6 months (March 23 – August 23)**				Good: ≥80% Moderate: 60-79 Poor:<60	**Good**
	District – Bhopal	100				
	Block-Berasia	100				
Proportion of district weekly review (DWR)	District – Bhopal	38%			Good: ≥80% Moderate: 60-79	**Good**

meetings conducted in last 6 months				Poor:<60	
Outbreak Response assessment	**Data for last 3 yrs.**			**Criteria**	**Assessment**
Proportion of flagged outbreaks with preliminary search done for the district Bhopal	2021 NA	2022 NA	2023 100	Good: ≥80% Moderate: 60-79 Poor:<60	**Good**
Median days between flagging of outbreak to prelim search (range) for the district Bhopal	NA	NA	-3 Days (14th Aug – 11th Aug)	Good: <3 days Moderate: 3-5 days Poor: >5 days	**Good**
Median days from preliminary search to Detail Investigation for District Bhopal	NA	NA	7 days (11th Aug-18th Aug)	Good: <2 days Moderate: 2-5 days Poor: >5 days	**Poor**
Median days Flagging outbreak to detail Investigation (range) for the district Bhopal	NA	NA	4 days (14th Aug-18th Aug)	Good: <3 days Moderate: 3-5 days Poor: >5 days	**Moderate**
Median days from First case rash onset to Index case notification for the district Bhopal	NA	NA	3 days (17th July to 20th July)	Good: <7 days Moderate:7-14 days Poor: >14 days	**Good**
Median days detail Investigation to sample collection (range) for the district Bhopal	NA	NA	2 days (18th Aug to 20th Aug)	Good: <3 days Moderate: 3-5 days Poor: >5 days	Good
Immunity assessment	**Data for last 3 yrs. In percentage** **2021 2022 2023**			**Criteria**	**Assessment**
MCV1 coverage trend - District Bhopal - Block Berasia	113 106	104 107	**98** **95**	Good: ≥95% Moderate: 80-94 % Poor: <80%	**Good**
MCV2 coverage trend - District Bhopal - Block Berasia	94 91	88 95	**87** 84	Good: ≥95% Moderate: 80-94 % Poor: <80%	**Moderate**
MCV1 RI Monitoring Data - District Bhopal - Block Berasia	96 95	94 89	**96** **95**	Good: ≥95% Moderate:80-94% Poor: <80%	**Good**
MCV2 RI Monitoring Data - District Bhopal - Block Berasia	80 78	89 85	**94** **91**	Good: ≥95% Moderate:80-94% Poor: <80%	**Moderate**

MCV1- MCV 2 Drop out - District Bhopal - Block Berasia	16 17	5 4	**2** **4**	Drop out was >15% in 2021	
Assessment for reason for missed vaccination	**Data for last 3 yrs. In percentage 2021 2022 2023**			**Criteria**	**Assessment**
Awareness gap - District Bhopal	0	23	16	High:- >10% Moderate- 5-10% Low- <5%	High
- Block Berasia	0	9	40		
Operational gap: - District Bhopal	0	10	5		Low
- Block Berasia	0	6	0		
Adverse Events Following Immunization (AEFI) Apprehension: - District Bhopal	6	23	53		High
- Block Berasia	9	40	40		
Refusal: - District Bhopal	5	10	1		High
- Block Berasia	9	17	7		
Routine immunization system assessment	Data			Criteria	**Assessment**
	2021	2022	2023		
District immunization officer (DIO) in place (Number of months any DIO has been in place in year /Total months in time-period)	12/12 months	12/ 12 Months	8/8 Months	Good: ≥80% Moderate: 60-79 Poor: <60	**Good**
RI Micro-plan availability	**Available and updated**			Good: available and good quality. Moderate: available, but poor quality. Poor: not available	**Good**
Micro-plan updated	**Updated in every 12 months** **Last April 2023**			**Good:** <6 months **Moderate:** 6-12 months **Poor:** >12 months	Good
Proportion of medical officers and vaccinators in position (MO filled/MO sanctioned*100 ANM filled/ ANM sanctioned*100)	District Bhopal		Block Berasia	Good: ≥80% Moderate: 60-79% Poor:<60%	Good
	MO	ANM	MO	ANM	

	81	89	86	85		

In this study, root cause assessment showed the goof routine immunization system in place with sensitive surveillance system where frontline worker of affected village able to identify, report and assist in cases investigation by sector medical officer. The outbreak response time was also good except mean days for Preliminary search to detail investigation. This showed the compliance with international and national guideline for measles and rubella elimination. (6,18–21) The District Bhopal as well as block Berasia achieved the Measles containing vaccine 1 (MCV1) coverage above 95% as per reported HMIS data and WHO monitored data but Measle containing vaccine 2 coverage is in between 80-95% in both reported and monitored data of last three years. The major reason for less vaccination coverage was awareness gap 40% and vaccine hesitancy due AEFI apprehension and refusal family 47% in block Berasia. This finding coincides with previous studies.(9,13,14)

Limitation

Poor vaccination card retention by household may pose recall bias while assessing the MCV 1 and MCV 2 coverage among the affected children. There were some families who were not willing the share the reason for partial or nil immunization for measles containing vaccine. These families were considered as refusal families.

CONCLUSIONS-

The outbreak investigated in village Pipaliya Hasnabad was laboratory-confirmed measles outbreak affecting children mainly in age group of 1 year to 10 years, majority in Muslim community. Major reasons for low coverage were awareness gap 16% at district and 40% at block level as well as Vaccine hesitancy in term of AEFI apprehension and refusal families was 54% at district and 47% at Block level.

Recommendation: - After the detail outbreak investigation, we had recommended to isolation all the positive as well epi-link cases either at hospital with proper management of cases, for those with complication and at home for those who are not having any complication. We also recommended to conduct quality Outbreak response immunization (ORI) in age group of 9 months to 10 years children to interrupt transmission as well as conduct head count survey of all under five children to assess the MCV 1, MCV 2 doses missed children and immunize them in ongoing Intensified Mission Indra Dhanush (IMI) drive (special immunization week for drop out and left children) in month of September and October 2023. For preventing future outbreak, we had recommended to build the capacity of frontline workers for social mobilization and community awareness drive and to reduce the AEFI apprehension regular community activity for awareness generation about benefits of immunization to be conducted. We also recommended to increase the Immunization session specially identified low coverage pockets to provide more opportunities to community to participate in RI drive and vaccinate their children.

As per our recommendation the Outbreak response immunization was conducted with coverage of 947(99%) children out of 959 children present in the affected population in the age group of 9months to 10 years. The Intensified Mission Indra Dhanush drive also achieved higher vaccination coverage of 9589 (89%) children in month of September and 7734(91%) in month of October 2023. The state also sent the field team for detail review of the outbreak and response to the Measles outbreak in month of September 2023.

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