

The Measles & Rubella Initiative

Survey to Identify Research Priorities for Accelerating Progress toward Measles and Rubella Elimination

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Background

The Global Vaccine Action Plan (GVAP), endorsed by the World Health Assembly (WHA) in 2012 established a global goal to achieve elimination of measles, rubella, and congenital rubella syndrome (CRS) by 2020 in five of the six WHO regions [1, 2]. Additionally, all WHO regions have set regional goals to achieve measles elimination by 2020, and three have established a goal for rubella elimination [3]. The Measles & Rubella Initiative (M&RI) is led by the American Red Cross, the United Nations Foundation, the U.S. Centers for Disease Control and Prevention (CDC), United Nations Children's Fund (UNICEF) and the World Health Organization (WHO). The M&RI Global Measles and Rubella Strategic Plan (2012–2020) has targets aligned with GVAP and outlines five core components for implementation to achieve the measles and rubella elimination goals: 1) achieve and maintain high levels of population immunity by providing high vaccination coverage with two doses of measles- and rubella-containing vaccines, 2) monitor disease using effective surveillance, and evaluate programmatic efforts to ensure progress, 3) develop and maintain outbreak preparedness, respond rapidly to outbreaks and manage cases, 4) communicate and engage to build public confidence and demand for immunization, and 5) perform the research and development needed to support cost-effective operations and improve vaccination and diagnostic tools [2].

Significant progress has been made toward achieving measles and rubella elimination through intensive efforts by countries and M&RI partners. Worldwide during 2000–2015, the number of measles cases reported declined 70% from 853,479 in 2000 to 254,928 in 2015 [3]. The estimated number of annual measles deaths decreased 79%, from 651,600 to 134,200. Estimated coverage with the routine first dose of measles-containing vaccine (MCV1) increased from 72% in 2000 to 85% in 2015 globally, and the number of countries with $\geq 90\%$ MCV1 coverage increased from 84 in 2000 to 119 in 2015 [4]. The number of countries providing a second dose of measles-containing vaccine (MCV2) through their national routine immunization services increased from 97 in 2000 to 160 in 2015, and estimated MCV2 coverage increased from 15% in 2000 to 61% in 2015 globally [4]. During 2000–2015, the number of rubella cases reported globally declined 95% from 670,894 in 2000 to 23,758 in 2015 [5, 6]. Estimated rubella-containing vaccine (RCV) coverage increased from 22% in 2000 to 46% in 2015 globally [4, 6]. SIAs implemented during 2015 in 41 countries vaccinated 184 million people with measles vaccine; 21 of these SIAs administered combined measles-rubella vaccine [7].

The Region of the Americas has verified elimination of measles (May 2016) and rubella (September 2015) [8]. The other five WHO regions have made progress, but will require further efforts to achieve measles and rubella elimination goals. Accelerating progress toward these goals will require evidence-based approaches for improving implementation of the core components in the Global Measles and Rubella Strategic Plan (2012–2020). In order to identify measles and rubella research questions considered to be the top priority for accelerating elimination efforts by scientific and programmatic experts, the Measles & Rubella Initiative Research and Innovation Work Group conducted a web-based survey. Results of the survey were presented at a 2-day meeting of experts held at Pan American Health Organization in Washington D.C. in November 2016, and were used to inform discussions about research priorities in four topic areas: 1) epidemiology and economics, 2) new tools for surveillance, vaccine delivery, and laboratory testing, 3) immunization

strategies and outbreak response, and 4) vaccine demand and communications. This report summarizes the findings of the web-based survey of measles and rubella research priorities.

Methods

Study Design and Recruitment

We conducted a cross-sectional survey to ask experts working in measles and/or rubella about research priorities for achieving measles and rubella elimination goals. CDC and the Measles & Rubella Initiative held an hour-long webinar on measles and rubella elimination goals and research priorities on October 17, 2016. After the webinar, invitations to complete a follow-up web survey were emailed to >750 individuals who attended or were invited to attend the webinar. The email recipients were instructed to forward the web survey invitation to others, in order to increase participation. The web survey was open for completion from October 17, 2016–November 4, 2016. Reminder emails were sent to non-responders and to individuals who began the survey but only partially completed it.

Survey Questions

Respondents were asked a set of questions (shown in Figure 1) for each of the four research categories:

- 1) Epidemiology and economics
- 2) New tools for surveillance, vaccine delivery, and laboratory testing
- 3) Immunization strategies and outbreak response
- 4) Vaccine demand and communications

Respondents were first asked to list the main implementation challenges that could be addressed by research in order to achieve measles and rubella elimination goals. This was open-ended, and up to three implementation challenges could be entered. Next, they were given a list of research questions, and asked to rate each research question’s significance (highly significant=4, moderately significant=3, low significance=2, not significant=1) and urgency (as soon as possible=3, by 2020=2, not essential by 2020=1) in order to achieve measles and rubella elimination goals. Next, they were asked to enter any key research questions they thought were missing from the list, and to rank those with regard to significance and urgency. Finally, they were asked to select the three highest priority research questions to achieve the measles and rubella global and regional elimination goals.

Figure 1. Survey questions asked for each of the four research categories.

Survey question	Responses
In the WHO region in which you have primarily worked, what do you think are the main implementation challenges related to <research category> that could be addressed by research to achieve measles and rubella global and regional elimination goals?	Open-ended Asked to list up to 3
How significant is each of the following <research category> research questions and how urgently should each of the research questions be addressed in order to achieve the measles and rubella global and regional elimination goals?	
Significance of the research question to achieve measles and rubella elimination goals	- Highly significant - Moderately significant - Low significance - Not significant
Urgency of the research question to achieve measles and rubella elimination goals	- As soon as possible - By 2020 - Not essential by 2020

If you think there are any key <research category> research questions missing, please enter them here.	Open-ended Asked to list up to 2
How significant is each of the missing <research category> research questions you entered and how urgently should each of the research questions be addressed in order to achieve the measles and rubella global and regional elimination goals?	
Significance of the research question to achieve measles and rubella elimination goals	- Highly significant - Moderately significant - Low significance - Not significant
Urgency of the research question to achieve measles and rubella elimination goals	- As soon as possible - By 2020 - Not essential by 2020
Among the <research category> research questions listed, which 3 have the highest priority to achieve the measles and rubella global and regional elimination goals?	Choose 3

Statistical Analysis

Data were analyzed for the total sample of respondents and stratified by the region that each respondent reported they primarily worked in. For the questions regarding research questions' significance and urgency, we used a numeric scale (Significance: highly significant=4, moderately significant=3, low significance=2, not significant=1; Urgency: as soon as possible=3, by 2020=2, not essential by 2020=1) to calculate means and standard deviations for responses.

Results

Demographics

A total of 163 individuals responded to the web survey during October 17, 2016–November 4, 2016, including 145 who answered all questions in the survey, and 18 who partially completed the survey and whose responses were included for the questions they answered. Any survey responses that provided demographics only (n=44) were not included in analyses. Respondents had immunization experience from all WHO regions, with the largest numbers from the African Region (AFR) (n=59), the global level (n=20), and the European Region (EUR) (n=33) (Table 1). Respondents work for a variety of organizations, including government/Ministry of Health (27%), the World Health Organization (25%), U.S. Centers for Disease Control (14%), universities (8%), UNICEF (7%), John Snow, Inc. (4%), independent immunization consultants (3%), and the American Red Cross (2%). Almost half of respondents have worked on measles and/or rubella for 10 years or longer (48%), and another 28% have worked on measles and/or rubella for 5–9 years.

Respondents' primary areas of expertise were both measles and rubella (44%), routine immunization service delivery (25%), measles only (11%), rubella only (2%), and other (18%) (n=3 not specified). Respondents characterized their current work on measles and/or rubella as national or sub-national measles and/or rubella program officer (21%), technical advisor/consultant (21%), routine immunization service delivery (11%), regional measles and/or rubella program officer (11%), researcher (11%), and global measles and/or rubella partner (10%). Eighteen respondents (11%) characterized their current work as 'Other' which included EPI focal point, immunization coordinator, demand and policy, epidemiologist, health officer providing technical support, director of national laboratory, member of Regional Verification Committee (RVC), and economist. Areas in which the largest proportions of respondents primarily work (could select more than one area) included epidemiology (51%), routine immunization service delivery (50%), field surveillance (44%), outbreak response (43%), campaigns

(41%), vaccine delivery (28%), and research (28%). Smaller numbers said that they worked in communications (15%), health behavior (5%), economics (5%), and mathematical modeling (2%).

Research Priorities

The results of the web survey on measles and rubella research priorities are presented in four sections:

- 1) Epidemiology and economics
- 2) New tools for surveillance, vaccine delivery, and laboratory testing
- 3) Immunization strategies and outbreak response
- 4) Vaccine demand and communications

Epidemiology and Economics

The epidemiology and economics research questions selected by the highest percentage of respondents as a top priority are shown in Figure 2. The three research questions with top priority were:

- What are the causes of outbreaks in settings with high reported vaccination coverage?
- What are the epidemiologic characteristics of measles (e.g., incidence, age distribution, case fatality ratios) in various settings in priority countries?
- What are the best methods for measuring progress toward measles and rubella elimination?

Significance and urgency scores were largely aligned with priorities, although notably the research question ‘How important is waning of measles immunity to achieving and sustaining elimination? What are the programmatic implications?’ had high average significance (3.5) and average urgency (2.3), but it was ranked as only the eighth highest research question in terms of priority (Tables 2a and 2b).

Figure 2. Highest priority epidemiology and economics research questions.

Research question	Percent who selected question as a top priority	Significance (mean)	Urgency (mean)
What are the causes of outbreaks in settings with high reported vaccination coverage?	47%	3.6	2.7
What are the epidemiologic characteristics of measles (e.g., incidence, age distribution, case fatality ratios) in various settings in priority countries?	34%	3.6	2.6
What are the best methods for measuring progress toward measles and rubella elimination?	27%	3.5	2.4
What is the optimal age of first and second doses of routine measles vaccination in different epidemiological settings?	26%	3.4	2.4
What are the potential implications of receiving MCV1 at an early age (e.g., prior to 9 months)?	24%	3.5	2.4
What is the prevalence of measles and rubella susceptibility among adolescents and adults in settings with persistent suboptimal measles/rubella vaccination coverage, and what is their role in sustaining measles virus transmission?			

The research questions with the highest priorities were related to epidemiology. Three economics questions were presented in the survey. The highest priority economics research question was “What is the cost of the level of surveillance needed to achieve measles and rubella elimination?”, and was selected as a top priority by 17% of survey respondents. The second highest priority economics research question was “What is the economic burden of measles outbreaks in low and middle income countries?”, and was selected as a top priority by 11% of survey respondents. The third highest priority economics research

question was “What is the economic burden of CRS at global, regional and national levels? Does the economic burden differ for low and middle income countries?”, and was selected as a top priority by just 3% of survey respondents.

Variation by Region

There was some variation by region in top priority research questions for epidemiology and economics. The same research question (‘What are the causes of outbreaks in settings with high reported vaccination coverage?’) was prioritized by respondents in AFR, the Region of the Americas (AMR), EUR, and the Western Pacific Region (WPR) (Table 2a). However, in the Eastern Mediterranean Region (EMR) the question with highest priority was ‘What are the epidemiologic characteristics of measles in various settings in priority countries?’ (63%), and in the South-East Asia Region (SEAR) the top priority question was ‘What is the optimal age of first and second doses of routine measles vaccination in different epidemiological settings? What are the potential implications of receiving MCV1 at an early age (e.g., prior to 9 months)?’ (62%). In WPR the same priority was given to two research questions: ‘What is the prevalence of measles and rubella susceptibility among adolescents and adults in settings with persistent suboptimal measles/rubella vaccination coverage, and what is their role in sustaining measles virus transmission?’ and ‘What are the causes of outbreaks in settings with high reported vaccination coverage?’ (both 55%).

Respondents working at the global level selected as the top priority research question ‘Can adults sustain measles virus transmission in the presence of high child immunity levels thereby making adult vaccination necessary to reach and maintain elimination?’ (47%).

Open-ended Responses

Survey respondents’ open-ended responses to the question ‘If you think there are any key epidemiology and economics research questions missing, please enter them here’ are shown in Table 2c, stratified by WHO region. There were a total of 53 new research topics listed, representing a variety of topic areas within epidemiology and economics.

Open-ended responses were also given for the survey question ‘In the WHO region in which you have primarily worked, what do you think are the main implementation challenges related to epidemiology and economics that could be addressed by research to achieve measles and rubella global and regional elimination goals?’, and there were 400 unique responses (Appendix 2. Tables 6a–6g).

Surveillance, Vaccine Delivery, and Laboratory Testing

The surveillance, vaccine delivery, and laboratory testing research questions selected by the highest percentage of respondents as a top priority are shown in Figure 3. The three research questions with top priority were:

- Can affordable diagnostic tests be developed to rapidly and accurately confirm measles and rubella cases at the point of care (POC)?
- Can vaccine safety, effectiveness, and/or coverage be improved by developing more thermo-stable vaccines, advanced vaccine vial temperature monitors, self-reconstituting vials, or by alternative delivery methods (e.g., needle-free injection devices, aerosol, dry powder inhalation, microneedles)?
- What is the effectiveness of two or more doses of measles-containing vaccine for achieving elimination in high birth rate densely populated settings in developing countries?

A majority of respondents agreed on the top priority question – affordable POC diagnostics (68%). Significance and urgency scores were largely aligned with priorities. However, notably the research question ‘What are the best methods to classify measles cases in outbreaks with a high proportion of vaccinated cases?’ had high average significance (3.6) and average urgency (2.3), but it was ranked as only the seventh highest research question in terms of priority (Tables 3a and 3b).

Figure 3. Highest priority surveillance, vaccine delivery, and laboratory testing research questions.

Research question	Percent who selected question as a top priority	Significance	Urgency
Can affordable diagnostic tests be developed to rapidly and accurately confirm measles and rubella cases at the point of care?	68%	3.7	2.6
Can vaccine safety, effectiveness, and/or coverage be improved by developing more thermo-stable vaccines, advanced vaccine vial temperature monitors, self-reconstituting vials, or by alternative delivery methods (e.g., needle-free injection devices, aerosol, dry powder inhalation, microneedles)?	60%	3.6	2.5
What is the effectiveness of two or more doses of measles-containing vaccine for achieving elimination in high birth rate densely populated settings in developing countries?	42%	3.5	2.4
What are valid performance indicators for measles and rubella case-based surveillance in different settings?	28%	3.6	2.6
What is the most appropriate method for determining level of population immunity in developing countries?	26%	3.6	2.5

Variation by Region

Four of the six WHO regions and global level selected the same research question as top priority (‘Can affordable diagnostic tests be developed to rapidly and accurately confirm measles and rubella cases at the point of care?’), with notably large majorities selecting this question as the highest priority (67%–77%) (Table 3a). However, in EMR the top priority question was ‘What is the effectiveness of two or more doses of measles-containing vaccine for achieving elimination in high birth rate densely populated settings in developing countries?’ (57%), and in WPR the top priority question was ‘Can vaccine safety, effectiveness, and/or coverage be improved by developing more thermo-stable vaccines, advanced vaccine vial temperature monitors, self-reconstituting vials, or by alternative delivery methods?’ (80%).

Open-ended Responses

Open-ended responses to the question ‘If you think there are any key surveillance, vaccine delivery, and laboratory testing research questions missing, please enter them here’ are shown in Table 3c, stratified by WHO region. There were a total of 18 new research topics listed, representing a variety of topic areas within surveillance, vaccine delivery, and laboratory testing.

Open-ended responses were also given for the survey question ‘In the WHO region in which you have primarily worked, what do you think are the main implementation challenges related to surveillance, vaccine delivery, and laboratory testing that could be addressed by research to achieve measles and rubella global and regional elimination goals?’ (Appendix 2. Tables 7a–7g).

Immunization Strategies and Outbreak Response

The immunization strategies and outbreak response research questions selected by the highest percentage of respondents as a top priority are shown in Figure 4. The three research questions with top priority were:

- What are effective strategies for increasing coverage of the routine first dose of measles vaccine administered at nine or 12 months?
- What are effective strategies for increasing coverage of the second dose given after the first year of life?
- What are effective strategies for identifying and vaccinating geographic or culturally hard-to-reach populations (e.g., nomadic populations, migrants, refugees, and internally displaced persons) in various settings?

Figure 4. Highest priority immunization strategies and outbreak response research questions.

Research question	Percent who selected question as a top priority	Significance score	Urgency score
What are effective strategies for increasing coverage of the routine first dose of measles vaccine administered at nine or 12 months?	53% (tie)	3.7	2.7
What are effective strategies for increasing coverage of the second dose given after the first year of life?	53% (tie)	3.8	2.7
What are effective strategies for identifying and vaccinating geographic or culturally hard-to-reach populations (e.g., nomadic populations, migrants, refugees, and internally displaced persons) in various settings?	46%	3.7	2.6
What are accurate, efficient, and novel methods for monitoring/verifying first- and second-dose measles vaccination coverage through routine immunization services and SIAs (e.g., serosurveys, coverage surveys, etc.)?	30%	3.6	2.5
What are the most cost-effective strategies for outbreak response immunization activities, including the timing of outbreak response immunization and selection of target populations?	29%	3.7	2.6

Variation by Region

The two research questions that were selected as top priority (‘What are effective strategies for increasing coverage of the routine first dose of measles vaccine administered at nine or 12 months?’ and ‘What are effective strategies for increasing coverage of the second dose given after the first year of life?’) were the top two priorities in AFR, AMR, WPR, and at the global level. AMR prioritized coverage of MCV1 over MCV2, while AFR and WPR conversely prioritized coverage of MCV2 over MCV1. Different priorities were reported in three regions: EMR, EUR, and SEAR. In EMR, the top priority research question was ‘What are effective strategies to maximize SIA coverage in different epidemiological settings?’ (67%). In EUR, the top priority research question was ‘What are effective strategies for identifying and vaccinating geographic or culturally hard-to-reach populations in various settings?’ (62%). And in SEAR, the two top priority research questions (tied) were ‘What are accurate, efficient, and novel methods for monitoring/verifying first- and second-dose measles vaccination coverage through routine immunization services and SIAs?’ and ‘What are the most cost-effective strategies for outbreak response immunization activities, including the timing of outbreak response immunization and selection of target populations?’ (each 46%).

Respondents working at the global level selected the same top priority research questions as respondents in AFR, AMR, and WPR ('What are effective strategies for increasing coverage of the routine first dose of measles vaccine administered at nine or 12 months?' and 'What are effective strategies for increasing coverage of the second dose given after the first year of life?').

Open-ended Responses

Open-ended responses to the question 'If you think there are any key immunization strategies and outbreak response research questions missing, please enter them here' are shown in Table 4c, stratified by WHO region. There were a total of 25 new research topics listed, representing a variety of topic areas within immunization strategies and outbreak response.

Open-ended responses were also given for the survey question 'In the WHO region in which you have primarily worked, what do you think are the main implementation challenges related to immunization strategies and outbreak response that could be addressed by research to achieve measles and rubella global and regional elimination goals?' (Appendix 2. Tables 8a–8g).

Vaccine Demand and Communications

The vaccine demand and communications research questions selected by the highest percentage of respondents as a top priority are shown in Figure 5. The three research questions with top priority were:

- How can communities best be engaged in planning, implementing and monitoring health services including vaccinations? What capacity-building is needed for health workers to be able to identify and work more effectively with community leaders?
- What are community attitudes and perceptions related to health services, immunizations, measles and rubella vaccination, and SIAs?
- What misconceptions and attitudinal barriers exist among public and private sector health care providers regarding measles- and rubella-containing vaccines?

Figure 5. Highest priority vaccine demand and communications research questions.

Research question	Percent who selected question as a top priority	Significance score	Urgency score
How can communities best be engaged in planning, implementing and monitoring health services including vaccinations? What capacity-building is needed for health workers to be able to identify and work more effectively with community leaders?	53%	3.6	2.6
What are community attitudes and perceptions related to health services, immunizations, measles and rubella vaccination, and SIAs?	41%	3.5	2.5
What misconceptions and attitudinal barriers exist among public and private sector health care providers regarding measles- and rubella-containing vaccines?	37%	3.4	2.4
What are the best strategies to address information gaps or confidence gaps in measles and rubella vaccines in different settings?	35%	3.5	2.5
What are effective strategies to enable health workers to obtain up-to-date information about the populations in their catchment areas and to	32%	3.4	2.4

Variation by Region

There was more variation by region in prioritizing research questions in this topic area compared with the other topic areas. The research question that was selected as top priority among all respondents ('How can communities best be engaged in planning, implementing and monitoring health services including vaccinations? What capacity-building is needed for health workers to be able to identify and work more effectively with community leaders?') was the top priority in four regions (AFR, EMR, SEAR, and WPR) (Table 5a). However, in EMR two other questions were equally prioritized ('What misconceptions and attitudinal barriers exist among public and private sector health care providers regarding measles- and rubella-containing vaccines' and 'What are effective strategies to enable health workers to obtain up-to-date information about the populations in their catchment areas and to understand their attitudes and perceived needs for health services?') (each 50%). In SEAR the question 'What are community attitudes and perceptions related to health services, immunizations, measles and rubella vaccination, and SIAs?' was also a high priority (62%). And in WPR, the two questions 'What are the best strategies to address information gaps or confidence gaps in measles and rubella vaccines in different settings?' and 'What are the primary reasons for low confidence and demand, and high confidence and demand, for immunization in general or for measles and rubella vaccination of specific age groups?' were also highly prioritized (50% each).

In AMR, the research question 'What are the most effective evidence-based strategies for measles and rubella vaccine acceptance?' was highest priority. In EUR, the highest priority was "What misconceptions and attitudinal barriers exist among public and private sector health care providers regarding measles- and rubella-containing vaccines?" At the global level, the top priority was 'What are the best strategies to address information gaps or confidence gaps in measles and rubella vaccines in different settings?'

Open-ended Responses

Open-ended responses to the question 'If you think there are any key vaccine demand and communications research questions missing, please enter them here' are shown in Table 5c, stratified by WHO region. There were a total of 12 new research topics listed, representing a variety of topic areas within vaccine demand and communications.

Open-ended responses were also given for the survey question 'In the WHO region in which you have primarily worked, what do you think are the main implementation challenges related to vaccine demand and communications that could be addressed by research to achieve measles and rubella global and regional elimination goals?' (Appendix 2. Tables 9a–9g).

Conclusions and Next Steps

To further progress toward achieving the GVAP goal to eliminate measles, rubella, and CRS in five of the six WHO regions by 2020, research and innovation will be critical [1, 3]. It will be vital to continue identifying and prioritizing the research questions with the most potential impact on achieving elimination goals [9]. Research prioritization efforts for measles and rubella/CRS have been conducted previously based on consensus from collaborative meetings attended by subject experts and expert input via surveys [9, 10]. The M&RI cross-sectional survey to identify research priorities for accelerating progress toward measles and rubella elimination, described here in this report, provided results that were used during the

November 2016 meeting of experts to inform discussions about research priorities in the four main categories: 1) epidemiology and economics, 2) new tools for surveillance, vaccine delivery, and laboratory testing, 3) immunization strategies and outbreak response, and 4) vaccine demand and communications. Data from the survey were reviewed by topic-based workgroups during the meeting, and combined with results from previous research prioritization activities, were used to develop research priorities for progressing to measles and rubella elimination.

The survey found that ranked priority research questions varied among the WHO regions. For example, in the Americas, the only region that has achieved elimination of both measles and rubella, the research questions ranked with the highest significance were related to economic burden of outbreaks and the cost of surveillance activities. In contrast, in the Eastern Mediterranean and South-East Asia regions, research on the epidemiology of measles in priority countries and the best methods for measuring progress toward elimination were ranked with the highest significance. And in the Western Pacific and African regions, research on the causes of outbreaks in settings with high vaccination coverage was ranked highest.

Overall, the research questions that were selected as the absolute highest priority by a majority of survey respondents were related to the development of new technologies to improve vaccination. The highest priority research question addressed whether affordable diagnostic tests can be developed to rapidly and accurately confirm measles and rubella cases at the point of care and the research question with the second highest priority addressed whether vaccine safety, effectiveness, and/or coverage can be improved by developing more thermo-stable vaccines, advanced vaccine vial temperature monitors, self-reconstituting vials, or by alternative delivery methods (e.g., needle-free injection devices, aerosol, dry powder inhalation, microneedles).

The results of this survey should be viewed in light of some limitations. First, respondents to the survey were a convenience sample of experts invited to the webinar in October 2016, based on a list of experts compiled by the M&RI Research & Innovation Work Group (RIWG). Additionally, invitees were asked to forward the web survey invitation to others, in order to increase participation. More than 750 individuals were invited to complete the survey. Because of this sampling design, the exact number of individuals who received a survey invitation was unknown; therefore, the survey response rate could not be calculated. Also, the survey participants likely did not include all measles and rubella experts globally. The survey was conducted via internet and in English, so individuals with poor internet connection, in non-English-speaking and resource-poor settings were underrepresented among survey respondents. We received some non-English responses that we translated and included in the results; however, other non-English speaking invitees did not participate in the survey. Second, the list of research questions presented in the survey was developed by a group of M&RI experts, and although this list was intended to be comprehensive, it was likely biased by the experts' own knowledge and subjective priorities. Open-ended response questions were purposively included in the survey in order to allow respondents to provide key additional research questions that were not already included in the survey. Through open-ended responses, survey participants identified an additional 105 high priority research questions that were missing from those listed specifically in the survey. Although this was important information, not all survey respondents ranked these additional research questions, and quantitative analysis of these open-ended responses was not possible. Third, the design and structural organization of the survey could have had an impact on the way respondents ranked priorities. For example, epidemiology topics and economics topics were categorized together, and so research questions from both topics were compared against each other in rankings. Thus, we found that in the epidemiology and economics category, research questions with the

highest priorities were related to epidemiology, and three research questions related to economics were ranked as lower priority.

Global research priorities will continue to evolve with further progress toward achieving the GVAP goals, as countries and regions move closer toward elimination. Periodic assessments of research priorities through future research prioritization processes will be critical for focusing research projects and guiding investments by stakeholders. Implementation of research to address the identified priorities will be instrumental in furthering progress toward elimination, and eventual eradication of measles and rubella/CRS. The M&RI RIWG will identify research-funding opportunities and implementation partners to ensure research and innovation activities provide the evidence that will be critical for setting policies and refining elimination strategies for success.

Appendix 1. Data Tables from Web Survey

Table 1. Demographic characteristics of respondents to the M&RI research priorities web survey, total and stratified by WHO region.

	Total (n=163)		WHO Region (%)						
	No.	%	AFR (n=59)	AMR (n=15)	EMR (n=8)	EUR (n=33)	SEAR (n=14)	WPR (n=12)	Global (n=20)
In which WHO region have most of your immunization activities or research been performed?									
African region	59	36.7	100.0	-	-	-	-	-	-
Region of the Americas	15	9.3	-	100.0	-	-	-	-	-
Eastern Mediterranean region	8	5.0	-	-	100.0	-	-	-	-
European region	33	20.5	-	-	-	100.0	-	-	-
South-East Asia region	14	8.7	-	-	-	-	100.0	-	-
Western Pacific region	12	7.5	-	-	-	-	-	100.0	-
Global level	20	12.4	-	-	-	-	-	-	100.0
Missing	2								
How would you best characterize your current work on measles and/or rubella?									
Global measles and/or rubella partner	16	10.0	8.5	-	-	3.1	-	8.3	45.0
National or sub-national measles and/or rubella program officer	34	21.3	20.3	20.0	25.0	40.6	21.4	8.3	-
Not primarily working on measles or rubella specifically now	7	4.4	8.5	6.7	-	-	-	-	5.0
Regional measles and/or rubella program officer	17	10.6	13.6	20.0	37.5	3.1	7.1	8.3	-
Researcher	17	10.6	3.4	6.7	-	18.8	21.4	16.7	15.0
Routine immunization service delivery	18	11.3	13.6	13.3	12.5	3.1	14.3	16.7	10.0
Technical advisor/consultant	33	20.6	28.8	20.0	12.5	9.4	21.4	41.7	5.0
Other	18	11.3	3.4	13.3	12.5	21.9	14.3	-	20.0
Missing	3					1			
What is your primary area of expertise?									
Both measles and rubella	70	43.8	29.3	46.7	62.5	60.6	57.1	50.0	35.0
Measles	18	11.3	17.2	13.3	-	9.1	-	8.3	10.0
Routine immunization service delivery	40	25.0	34.5	33.3	25.0	9.1	28.6	25.0	15.0
Rubella	3	1.9	-	-	-	3.0	-	8.3	5.0
Other	29	18.1	19.0	6.7	12.5	18.2	14.3	8.3	35.0
Missing	3		1						
In which of the following areas do you primarily work? (may choose more than one)									
Epidemiology	83	50.9	71.2	26.7	62.5	21.2	71.4	41.7	45.0

Routine immunization service delivery	82	50.3	47.5	46.7	75.0	36.4	50.0	41.7	35.0
Field surveillance	72	44.2	1.7	20.0	12.5	54.6	28.6	41.7	10.0
Outbreak response	70	42.9	35.6	20.0	37.5	18.2	28.6	16.7	35.0
Campaigns	67	41.1	47.5	40.0	75.0	39.4	57.1	33.3	25.0
Vaccine delivery	46	28.2	57.6	33.3	75.0	15.2	57.1	33.3	25.0
Research	46	28.2	1.7	6.7	12.5	3.0	7.1	8.3	5.0
Laboratory	34	20.9	8.5	13.3	37.5	12.1	7.1	16.7	-
Health systems	31	19.0	5.1	13.3	12.5	39.4	14.3	25.0	10.0
Diagnostics	26	16.0	-	-	-	15.2	-	8.3	5.0
Communications	25	15.3	-	-	12.5	15.2	7.1	8.3	10.0
Molecular epidemiology	23	14.1	47.5	46.7	75.0	51.5	50.0	58.3	55.0
Vaccine procurement	17	10.4	1.7	20.0	12.5	39.4	14.3	8.3	10.0
Immunology	10	6.1	1.7	6.7	-	6.1	7.1	8.3	10.0
Health behaviors	8	4.9	3.4	6.7	12.5	-	-	-	20.0
Economics	8	4.9	11.9	6.7	37.5	15.2	21.4	25.0	15.0
Vaccine development	7	4.3	15.3	20.0	37.5	36.4	42.9	33.3	45.0
Pathogenesis	7	4.3	1.7	6.7	-	-	-	-	5.0
Mathematical modeling	3	1.8	8.47	20.0	-	9.1	-	-	20.0
Other	15	9.2	15.3	26.7	25.0	15.2	21.4	33.3	20.0
How long have you worked on measles and/or rubella (in any capacity)?									
<1 year	8	5.0	5.2	-	-	12.1	-	-	5.0
1 to 5 years	31	19.4	24.1	13.3	25.0	9.1	14.3	8.3	35.0
5 to 9 years	44	27.5	27.6	20.0	50.0	30.3	28.6	41.7	10.0
10 to 20 years	50	31.3	34.5	33.3	12.5	30.3	42.9	33.3	20.0
More than 20 years	27	16.9	8.6	33.3	12.5	18.2	14.3	16.7	30.0
Missing	3		1						
Which of the following organizations do you currently work for?									
American Red Cross	3	1.9	5.1	-	-	-	-	-	-
Bill and Melinda Gates Foundation	2	1.2	3.4	-	-	-	-	-	-
Government/Ministry of Health	43	26.7	18.6	46.7	25.0	45.5	28.6	33.3	-
Independent immunization consultant	5	3.1	3.4	6.7	12.5	-	-	-	5.0
John Snow, Inc. (JSI)	6	3.7	6.8	-	-	-	-	8.3	5.0
Medecins Sans Frontieres/Epicentre	1	0.6	1.7	-	-	-	-	-	-
U.S. Centers for Disease Control and Prevention	22	13.7	11.9	13.3	-	3.0	-	16.7	50.0
UNICEF	12	7.5	13.6	-	37.5	-	-	8.3	-
University/Academic/Clinician	13	8.1	3.4	13.3	-	12.1	21.4	8.3	5.0
World Health Organization	41	25.5	32.2	20.0	25.0	9.1	50.0	25.0	20.0
Other	13	8.1	-	-	-	30.3	-	-	15.0
Missing	2								

Table 2a. Highest priority **epidemiology and economics** research questions, total and stratified by WHO region.

Epidemiology and economics research questions	Proportion (%) who chose this question as 1 of the top 3 priority research questions							
	Total (n=157)	AFR (n=58)	AMR (n=15)	EMR (n=8)	EUR (n=32)	SEAR (n=13)	WPR (n=11)	Global (n=19)
b. What are the causes of outbreaks in settings with high reported vaccination coverage?	46	47	47	25	53	54	55	32
a. What are the epidemiologic characteristics of measles (e.g., incidence, age distribution, case fatality ratios) in various settings in priority countries?	34	36	20	63	25	46	36	32
i. What are the best methods for measuring progress toward measles and rubella elimination?	27	26	20	25	34	31	27	21
f. What is the optimal age of first and second doses of routine measles vaccination in different epidemiological settings? What are the potential implications of receiving MCV1 at an early age (e.g., prior to 9 months)?	26	28	20	13	25	62	18	16
c. What is the prevalence of measles and rubella susceptibility among adolescents and adults in settings with persistent suboptimal measles/rubella vaccination coverage, and what is their role in sustaining measles virus transmission?	24	21	40	25	19	23	55	11
d. Can adults sustain measles virus transmission in the presence of high child immunity levels thereby making adult vaccination necessary to reach and maintain elimination?	22	7	33	25	19	31	36	47
g. What is the need to vaccinate older children, adolescents, and adults in supplemental immunization activities?	22	19	27	38	22	15	9	32
m. What is the cost of the level of surveillance needed to achieve measles and rubella elimination?	17	19	13	38	9	15	9	26
p. How important is waning of measles immunity to achieving and sustaining elimination? What are the programmatic implications?	17	14	27	13	25	0	18	16
e. At what age do infants lose protection from maternal measles-specific antibodies in different epidemiological settings?	15	14	27	13	13	23	9	16
k. What are the best methods to estimate the threshold population size and susceptible density required to sustain measles and/or rubella virus transmission in various settings?	11	21	0	13	9	0	9	0

l. What is the economic burden of measles outbreaks in low and middle income countries?	11	12	7	0	16	8	18	5
j. What are the best methods for measuring disease burden of measles and rubella?	8	9	0	13	9	15	0	5
n. What is the epidemiology of rubella/CRS in developing countries with different birth rates?	8	14	7	0	9	0	0	0
h. What is the prevalence of measles virus susceptibility among human immunodeficiency virus (HIV)-infected adults in high HIV-prevalence settings and does this depend on coverage of HAART?	4	10	0	0	3	0	0	0
o. What is the economic burden of CRS at global, regional and national levels? Does the economic burden differ for low and middle income countries?	3	3	0	0	0	0	0	16

Table 2b. Significance and urgency of **epidemiology and economics** research priorities, total and stratified by WHO region.

Epidemiology and economics research questions	Significance, mean ¹		Urgency, mean ²	Significance, mean ¹						
	Total (n=159)			AFR (n=59)	AMR (n=15)	EMR (n=8)	EUR (n=33)	SEAR (n=14)	WPR (n=12)	Global (n=18)
	Mean	SD	Total (n=155)							
a. What are the epidemiologic characteristics of measles (e.g., incidence, age distribution, case fatality ratios) in various settings in priority countries?	3.6	0.6	2.6	3.6	3.4	3.9	3.6	3.9	3.6	3.7
b. What are the causes of outbreaks in settings with high reported vaccination coverage?	3.6	0.6	2.7	3.7	3.3	3.5	3.5	3.6	4.0	3.5
i. What are the best methods for measuring progress toward measles and rubella elimination?	3.5	0.7	2.4	3.6	3.2	3.8	3.7	3.8	3.5	2.9
p. How important is waning of measles immunity to achieving and sustaining elimination? What are the programmatic implications?	3.5	0.7	2.3	3.5	3.5	3.6	3.6	3.6	3.3	3.2
g. What is the need to vaccinate older children, adolescents, and adults in supplemental immunization activities?	3.5	0.6	2.4	3.5	3.3	3.6	3.6	3.2	3.5	3.6
c. What is the prevalence of measles and rubella susceptibility among adolescents and adults in settings with persistent suboptimal measles/rubella vaccination coverage, and what is their role in sustaining measles virus transmission?	3.5	0.7	2.4	3.4	3.4	3.3	3.5	3.6	3.8	3.2
m. What is the cost of the level of surveillance needed to achieve measles and rubella elimination?	3.5	0.7	2.4	3.6	3.5	3.4	3.4	3.4	2.8	3.4
f. What is the optimal age of first and second doses of routine measles vaccination in different epidemiological settings? What are the potential implications of receiving MCV1 at an early age (e.g., prior to 9 months)?	3.4	0.7	2.4	3.5	3.3	3.4	3.3	3.7	3.6	3.1
l. What is the economic burden of measles outbreaks in low and middle income countries?	3.4	0.7	2.3	3.5	3.5	3.6	3.1	3.6	3.2	3.0
k. What are the best methods to estimate the threshold population size and susceptible density required to sustain measles and/or rubella virus transmission in various settings?	3.3	0.7	2.3	3.5	2.7	3.8	3.4	3.6	3.5	2.9

n. What is the epidemiology of rubella/CRS in developing countries with different birth rates?	3.3	0.7	2.3	3.5	3.3	3.8	3.3	3.3	3.0	3.1
j. What are the best methods for measuring disease burden of measles and rubella?	3.2	0.8	2.2	3.4	2.9	3.1	3.3	3.8	2.9	2.7
o. What is the economic burden of CRS at global, regional and national levels? Does the economic burden differ for low and middle income countries?	3.2	0.7	2.6	3.3	3.3	3.4	3.2	3.4	2.9	3.2
e. At what age do infants lose protection from maternal measles-specific antibodies in different epidemiological settings?	3.2	0.8	2.1	3.2	3.3	3.3	3.1	3.4	3.2	2.9
d. Can adults sustain measles virus transmission in the presence of high child immunity levels thereby making adult vaccination necessary to reach and maintain elimination?	3.1	0.7	2.1	3.1	3.1	3.3	3.2	2.9	3.2	3.5
h. What is the prevalence of measles virus susceptibility among human immunodeficiency virus (HIV)-infected adults in high HIV-prevalence settings and does this depend on coverage of HAART?	2.6	0.8	1.7	2.7	2.6	2.3	2.7	2.6	2.2	2.4

¹ Answers were given the following values: 1=not significant, 2=low significance, 3=moderately significant, 4=highly significant.

² Answers were given the following values: 1=not essential by 2020, 2=by 2020, 3=as soon as possible.

Table 2c. Key additional epidemiology and economics research questions.

	Significance	Urgency
AFR		
Country by country analysis of strategy for elimination	High	As soon as possible
Does rubella and measles surveillance data reflect the true age distribution of cases in the population	High	As soon as possible
Effect of 5 dose measles vial for improved measles coverage.	High	As soon as possible
evaluate new WHO recommendations on MCV use including countries where younger age/wider age groups included	High	As soon as possible
High quality intervention trials of different routine vaccination strategies in priority countries	High	As soon as possible
How important is correct target population estimation to understanding the population at risk?	High	As soon as possible
rapid diagnostic tests like the malaria in the field to have prompt confirmation	High	As soon as possible
To what extent is community involved in measles-rubella elimination strategies in high risk countries	High	As soon as possible
What are the main reasons for non-vaccination of children in accessible highly populated areas	High	As soon as possible
What is the immunogenicity of measles and rubella among malnourished children especially in African region where chronic malnutrition is higher in children (more than 30%...)	High	As soon as possible
What is the role and cost of interpersonal communication on measles and rubella at household level in countries with high burden of measles and rubella disease compared to other modes of communication	High	As soon as possible
what options for sustainable financing of measles rubella programs in high burden LMIC	High	As soon as possible
country level research on Kimberly Thompson's work, costs of elimination vs. high control	High	By 2020
Evaluation of KAP among pediatricians around immunization, and gynecologist about CRS	High	By 2020
Measles 5 dose operational study	High	By 2020
role of viral seeding, from town to country, in measles transmission	High	By 2020
What is the optimum (most cost effective) interval between SIA to achieve measles elimination	High	By 2020
at what level of under five proportion of measles cases does measles incidence stabilize	Moderate	By 2020
High quality intervention trials of different SIA strategies	Moderate	By 2020
what tools and methods do accurately assess risk of measles outbreak in areas where coverage is not reliable and measles cases are reported in every district	Moderate	By 2020
what is the cost effectiveness of introducing new microarray patches		
AMR		
Cost of MR vaccine hesitancy	High	As soon as possible
Estudo da imunidade pós vacinal. Estudo de proteção transplacentária. [Study of immunity after vaccination. Study of transplacental protection.]	High	As soon as possible
Estudo de soroprevalência de sarampo e rubéola. [Seroprevalence study of measles and rubella.]	High	As soon as possible
Role of population mobility (particularly adults) and/or migration factors in measles transmission and dissemination	High	As soon as possible
The impact of a focus on measles/rubella on reducing the burden of all VPDs (i.e., can a focus on measles and rubella enhance the overall immunization system).	High	As soon as possible
EMR		
strengthening of routine immunization coverage	High	As soon as possible
EUR		
Illustrate the cost of elimination versus the cost of continued disease	High	As soon as possible
Re: economics- consider presenting economic scenarios to national EPI program to determine how important the role of economics actually is	High	As soon as possible

vaccine hesitancy impact on immunization coverage	High	As soon as possible
What and how many supplemental vaccination activities are needed according to vaccination coverage per age group and migration (modelling)	High	As soon as possible
what are the main factors of population distrust on measles containing vaccine safety research outcomes	High	As soon as possible
What is the participation of nosocomial transmission in outbreaks	High	As soon as possible
Why vaccine coverage is low on special risk populations (Roma, travelers..)	High	As soon as possible
Does receiving MCV1 at an early age (e.g., prior to 9 months) negatively impact longevity of protection, and if so what are the epidemiological consequences?	High	By 2020
SEAR		
threshold rate for non-measles non-rubella cases of fever and rash in population	High	As soon as possible
What is the level of immunity acquired after MCV2 in children?	High	As soon as possible
Develop practical indicators to measure and evaluate the quality of measles surveillance	High	
antibody level below 9 months infants	Moderate	As soon as possible
antibody level of different set of age group	Moderate	As soon as possible
Interference in immunogenicity of measles vaccine with other concomitant vaccinations	Moderate	
WPR		
Role of nosocomial transmission in outbreaks?	Moderate	By 2020
GLOBAL		
Can adults sustain rubella virus transmission in the presence of high child immunity levels thereby making adult vaccination necessary to reach and maintain elimination?	High	As soon as possible
Change "elimination" to "eradication"	High	As soon as possible
Economic impact of reaching chronically hard to reach populations for measles and rubella vaccination	High	As soon as possible
Equity. Also note I have made some of these lower priority because they are essential parts of routine public health program evaluation, surveillance and outbreak response, in which they are essential	High	As soon as possible
impact of diminishing polio resources on disease burden and economic impact	High	As soon as possible
We know how to measure disease burden. We don't know how to get good vital statistics a priority in countries where they don't exist, because it is not an exciting area for funding	High	As soon as possible
What is the immunity threshold required to achieve and sustain interruption of measles and/or rubella virus transmission in various settings?	High	As soon as possible
What will measles and rubella eradication cost?	High	As soon as possible
What is the best way to use age distribution of outbreak cases and results of vaccination activities to estimate the age range of the gap in population immunity and the proportion of the gap that needs to be filled to reach herd immunity?	High	By 2020
Economic impact of reaching coverage targets and thresholds	Moderate	By 2020
Is 90% MCV1 coverage essential for achieving and maintaining elimination in large countries?	Moderate	By 2020

Table 3a. Highest priority new tools for surveillance, vaccine delivery, and laboratory testing research questions, total and stratified by WHO region.

New tools for surveillance, vaccine delivery, and laboratory testing research questions	Proportion (%) who chose this question as 1 of the top 3 priority research questions							
	Total (n=144)	AFR (n=53)	AMR (n=12)	EMR (n=7)	EUR (n=29)	SEAR (n=13)	WPR (n=10)	Global (n=18)
c. Can affordable diagnostic tests be developed to rapidly and accurately confirm measles and rubella cases at the point of care?	68	70	67	43	72	77	60	72
b. Can vaccine safety, effectiveness, and/or coverage be improved by developing more thermo-stable vaccines, advanced vaccine vial temperature monitors, self-reconstituting vials, or by alternative delivery methods (e.g., needle-free injection devices, aerosol, dry powder inhalation, microneedles)?	60	68	58	43	41	62	80	61
a. What is the effectiveness of two or more doses of measles-containing vaccine for achieving elimination in high birth rate densely populated settings in developing countries?	42	47	25	57	38	69	30	28
h. What are valid performance indicators for measles and rubella case-based surveillance in different settings?	28	32	33	14	14	38	30	33
k. What is the most appropriate method for determining level of population immunity in developing countries?	26	30	8	14	28	15	60	17
i. What is the global distribution of circulating measles virus genotypes and which genotypes have been eliminated? Is there necessity for more specific lineage information to map progress?	14	15	17	43	17	0	10	0
l. What are the best methods to classify measles cases in outbreaks with a high proportion of vaccinated cases?	12	9	17	14	21	8	0	11
g. What are the optimal methods and corresponding costs for identifying CRS cases (e.g., using a single or combination of birth defects), particularly in areas with weak health system infrastructure?	12	8	33	29	7	8	0	22
j. What is the global distribution of circulating rubella virus genotypes and which genotypes have been eliminated? Is there necessity for more specific lineage information to map progress?	10	9	0	14	21	0	10	6
e. What molecular sequencing methods can be used to distinguish between closely related measles and rubella viruses?	10	4	25	14	17	0	10	11
f. What are the technical requirements and epidemiologic utility of developing serologic assays to differentiate	9	13	0	0	10	8	0	6

immunity acquired from exposure to wild-type viruses
and immunity acquired from exposure to vaccine strains?

d. Can tests be developed to accurately measure
neutralizing antibodies to measles and rubella viruses,
and provide results faster than the plaque reduction
neutralization assay (PRNT)?

8

9

17

0

14

0

0

6

Table 3b. Significance and urgency of **new tools for surveillance, vaccine delivery, and laboratory testing** research priorities, total and stratified by WHO region.

New tools for surveillance, vaccine delivery, and laboratory testing research questions	Significance, mean ¹		Urgency, mean ²	Significance, mean ¹						
	Total (n=145)		Total	AFR	AMR	EMR	EUR	SEAR	WPR	Global
	Mean	SD	(n=143)	(n=54)	(n=13)	(n=7)	(n=29)	(n=14)	(n=10)	(n=17)
c. Can affordable diagnostic tests be developed to rapidly and accurately confirm measles and rubella cases at the point of care?	3.7	0.5	2.6	3.8	3.6	3.4	3.9	3.9	3.6	3.5
k. What is the most appropriate method for determining level of population immunity in developing countries?	3.6	0.6	2.5	3.6	3.3	3.9	3.8	3.8	3.7	3.4
l. What are the best methods to classify measles cases in outbreaks with a high proportion of vaccinated cases?	3.6	0.6	2.3	3.6	3.3	3.9	3.8	3.8	3.7	3.4
b. Can vaccine safety, effectiveness, and/or coverage be improved by developing more thermo-stable vaccines, advanced vaccine vial temperature monitors, self-reconstituting vials, or by alternative delivery methods (e.g., needle-free injection devices, aerosol, dry powder inhalation, microneedles)?	3.6	0.7	2.5	3.5	3.3	3.6	3.6	3.7	3.9	3.6
h. What are valid performance indicators for measles and rubella case-based surveillance in different settings?	3.6	0.6	2.6	3.7	3.3	4.0	3.5	3.8	3.4	3.5
a. What is the effectiveness of two or more doses of measles-containing vaccine for achieving elimination in high birth rate densely populated settings in developing countries?	3.5	0.8	2.4	3.5	3.2	3.9	3.5	3.8	3.4	2.9
g. What are the optimal methods and corresponding costs for identifying CRS cases (e.g., using a single or combination of birth defects), particularly in areas with weak health system infrastructure?	3.3	0.7	2.2	3.4	3.3	3.7	3.5	3.1	2.9	3.0
d. Can tests be developed to accurately measure neutralizing antibodies to measles and rubella viruses, and provide results faster than the plaque reduction neutralization assay (PRNT)?	3.2	0.7	2.0	3.3	3.2	3.0	3.4	3.6	3.0	2.8
i. What is the global distribution of circulating measles virus genotypes and which genotypes have been eliminated? Is there necessity for more specific lineage information to map progress?	3.17	0.7	2.04	3.1	2.9	3.6	3.4	3.3	3.1	2.9

j. What is the global distribution of circulating rubella virus genotypes and which genotypes have been eliminated? Is there necessity for more specific lineage information to map progress?	3.16	0.7	2.09	3.1	3.0	3.3	3.5	3.1	3.1	2.9
e. What molecular sequencing methods can be used to distinguish between closely related measles and rubella viruses?	3.10	0.8	1.99	2.9	3.3	3.3	3.4	3.2	3.0	2.9
f. What are the technical requirements and epidemiologic utility of developing serologic assays to differentiate immunity acquired from exposure to wild-type viruses and immunity acquired from exposure to vaccine strains?	3.02	0.8	1.81	3.0	2.8	2.8	3.4	3.3	2.8	2.5

¹ Answers were given the following values: 1=not significant, 2=low significance, 3=moderately significant, 4=highly significant.

² Answers were given the following values: 1=not essential by 2020, 2=by 2020, 3=as soon as possible.

Table 3c. Key additional new tools for surveillance, vaccine delivery, and laboratory testing research questions.

	Significance	Urgency
AFR		
Household survey probability sampling methods that are practicable for reasonable budget in LMICS	High	As soon as possible
Methods to get better denominator data for surveillance and coverage (and for program planning)	High	As soon as possible
serosurveys as a planning and management tool	High	As soon as possible
the potential use of mobile technology and GIS mapping in measles surveillance	High	As soon as possible
new diagnostic tests using noninvasive methods	High	By 2020
developing applications and algorithms that help predict population immunity for measles from measles case based surveillance data	Moderate	By 2020
AMR		
Robust thresholds of immunity for both measles and rubella		
EMR		
EUR		
What is the best method in determining previous exposure to either measles virus or measles vaccine	High	As soon as possible
Are there mutations able to enhance transmissibility?	Moderate	By 2020
SEAR		
android based reporting and response strategy	High	As soon as possible
web based supply chain, vaccine management	High	As soon as possible
Multiplex assays for simultaneous testing of multiple antigens would reduce the cost and operational need to conduct serosurveys for each disease separately	High	
WPR		
Methods to differentiate primary and secondary infection	Moderate	By 2020
GLOBAL		
comparing costs and effectiveness of campaign and routine delivery	High	As soon as possible
How to conduct surveillance of a new 2nd year of life (MCV2) platform	High	As soon as possible
How to get high coverage in hard to reach groups	High	As soon as possible
equity focused approaches to delivery	Moderate	By 2020
how to use social media to improve identification of outbreaks in a timely manner	Moderate	By 2020

Table 4a. Highest priority immunization strategies and outbreak response research questions, total and stratified by WHO region.

Immunization strategies and outbreak response research questions	Proportion (%) who chose this question as 1 of the top 3 priority research questions							
	Total (n=142)	AFR (n=52)	AMR (n=12)	EMR (n=6)	EUR (n=29)	SEAR (n=13)	WPR (n=10)	Global (n=18)
a. What are effective strategies for increasing coverage of the routine first dose of measles vaccine administered at nine or 12 months?	53	50	67	50	55	31	50	61
b. What are effective strategies for increasing coverage of the second dose given after the first year of life?	53	54	58	50	45	38	70	61
e. What are effective strategies for identifying and vaccinating geographic or culturally hard-to-reach populations (e.g., nomadic populations, migrants, refugees, and internally displaced persons) in various settings?	46	38	42	50	62	38	50	44
d. What are accurate, efficient, and novel methods for monitoring/verifying first- and second-dose measles vaccination coverage through routine immunization services and SIAs (e.g., serosurveys, coverage surveys, etc.)?	30	31	25	50	24	46	40	11
f. What are the most cost-effective strategies for outbreak response immunization activities, including the timing of outbreak response immunization and selection of target populations?	29	33	42	0	28	46	20	17
c. What are effective strategies (e.g., house-to-house social mobilization) to maximize SIA coverage in different epidemiological settings?	23	23	25	67	14	31	20	17
h. What are the key strategies for reducing missed opportunities for measles vaccination (e.g., integration with other preventive services, strengthening connections to curative services, reducing doses per vial)?	21	31	17	0	14	23	20	17
i. What are effective strategies to create a motivated and knowledgeable healthcare workforce equipped to routinely administer MCV (e.g., supervision, cash incentives, peer to peer benchmarking, etc.)?	18	17	17	17	24	23	0	17
g. How do we improve recording and reporting of routine measles vaccinations at the facility level (e.g., through registers and tally sheets and among households through the home based vaccination record)?	12	17	0	33	17	8	0	0
j. What are methods for monitoring and ensuring sustainable MCV vaccine supply at a country level, particularly in GAVI graduating countries and non-GAVI eligible low- and middle-income countries?	12	12	0	17	14	0	10	28

Table 4b. Significance and urgency of immunization strategies and outbreak response research priorities, total and stratified by WHO region.

Immunization strategies and outbreak response research questions	Significance, mean ¹		Urgency, mean ²	Significance, mean ¹						
	Total (n=142)		Total (n=139)	AFR (n=52)	AMR (n=12)	EMR (n=6)	EUR (n=29)	SEAR (n=14)	WPR (n=10)	Global (n=18)
	Mean	SD								
b. What are effective strategies for increasing coverage of the second dose given after the first year of life?	3.8	0.4	2.7	3.8	3.8	4.0	3.7	3.8	3.9	3.7
a. What are effective strategies for increasing coverage of the routine first dose of measles vaccine administered at 9 or 12 months?	3.7	0.6	2.7	3.7	3.8	4.0	3.7	3.6	3.6	3.7
e. What are effective strategies for identifying and vaccinating geographic or culturally hard-to-reach populations (e.g., nomadic populations, migrants, refugees, and internally displaced persons) in various settings?	3.7	0.6	2.6	3.7	3.5	4.0	3.8	3.7	3.8	3.6
f. What are the most cost-effective strategies for outbreak response immunization activities, including the timing of outbreak response immunization and selection of target populations?	3.7	0.5	2.6	3.8	3.6	4.0	3.7	3.9	3.4	3.5
d. What are accurate, efficient, and novel methods for monitoring/verifying first- and second-dose measles vaccination coverage through routine immunization services and SIAs (e.g., serosurveys, coverage surveys, etc.)?	3.6	0.5	2.5	3.7	3.3	3.7	3.6	3.8	3.7	3.5
h. What are the key strategies for reducing missed opportunities for measles vaccination (e.g., integration with other preventive services, strengthening connections to curative services, reducing doses per vial)?	3.6	0.6	2.5	3.7	3.5	3.5	3.6	3.5	3.5	3.5
c. What are effective strategies (e.g., house-to-house social mobilization) to maximize SIA coverage in different epidemiological settings?	3.5	0.6	2.5	3.5	3.4	3.8	3.6	3.7	3.4	3.6
i. What are effective strategies to create a motivated and knowledgeable healthcare workforce equipped to routinely administer MCV (e.g., supervision, cash incentives, peer to peer benchmarking, etc.)?	3.4	0.7	2.3	3.4	3.2	3.7	3.7	3.5	3.1	3.2
g. How do we improve recording and reporting of routine measles vaccinations at the facility level (e.g., through registers and tally sheets and among households through the home based vaccination record)?	3.4	0.7	2.3	3.4	3.3	4.0	3.3	3.6	3.2	3.1
j. What are methods for monitoring and ensuring sustainable MCV vaccine supply at a country level, particularly in GAVI graduating countries and non-GAVI eligible low- and middle-income countries?	3.4	0.8	2.3	3.4	3.0	3.8	3.4	3.2	3.5	3.3

¹ Answers were given the following values: 1=not significant, 2=low significance, 3=moderately significant, 4=highly significant.

² Answers were given the following values: 1=not essential by 2020, 2=by 2020, 3=as soon as possible.

Table 4c. Key additional immunization strategies and outbreak response research questions.

	Significance	Urgency
AFR		
Determination of size and scope of outbreak response	High	As soon as possible
Role of GIS in improving coverage	High	As soon as possible
evaluating use of SIA preparedness tools	High	As soon as possible
ways to improve MCV2 coverage	High	As soon as possible
What are ways to maximise the use of improved denominator data (e.g. Worldpop data) for planning and monitoring services?	High	By 2020
What could be the best way to organize health center activities considering number of health staff?	High	By 2020
what are better strategies of maintaining measles vaccine potency in difficult settings	High	By 2020
Intervention trials of strategies for community engagement in high priority countries	High	By 2020
Role of zero dose vaccinations in outbreaks and impact at population level on vaccine efficacy		
What is the role of retesting, and appropriate frequency of retesting, to confirm ongoing measles and rubella outbreaks		
AMR		
Can outbreak response be used to overcome vaccine hesitancy	Moderate	By 2020
Can outbreak response enhance the overall immunization system	Moderate	By 2020
EUR		
What are effective strategies to improve confidence on vaccination on developed countries?	High	As soon as possible
What will be our immunization strategy during the "endgame" of a global MR eradication campaign?	High	By 2020
What will be our immunization strategy if MR eradication is successful?	High	By 2020
SEAR		
immediate case management and response to wider age group	High	As soon as possible
Search and immunize	High	As soon as possible
WPR		
GLOBAL		
How best to close the immunity gaps in older populations?	High	As soon as possible
Policy research on advocacy and increasing political commitment to elimination and eradication at regional, country and global levels	High	As soon as possible
What are the effective strategies in improving quality of Supplementary Immunization Activities?	High	As soon as possible
What level of population immunity is needed for herd immunity in different settings?	High	By 2020
indicators to guide needed extent of ORIs (by age and geographically)	High	Not essential by 2020
What are effective strategies to increase demand for MCV2 after the first year of life in different settings and for different populations? (sub-question of increasing coverage (Qb), but focused on demand generation)	Moderate	As soon as possible
What is the cost and cost-effectiveness of different strategies to vaccinate hard-to-reach populations (sub-question of effectiveness, but focused on costs and cost-effectiveness)	Moderate	As soon as possible
urban settings - most models for delivery are based on rural - we need to think more about urban settings	Moderate	By 2020

Table 5a. Highest priority vaccine demand and communications research questions, total and stratified by WHO region.

Vaccine demand and communications research questions	Proportion (%) who chose this question as 1 of the top 3 priority research questions							
	Total (n=144)	AFR (n=53)	AMR (n=13)	EMR (n=6)	EUR (n=29)	SEAR (n=13)	WPR (n=10)	Global (n=19)
d. How can communities best be engaged in planning, implementing and monitoring health services including vaccinations? What capacity-building is needed for health workers to be able to identify and work more effectively with community leaders?	53	70	31	50	41	62	50	37
a. What are community attitudes and perceptions related to health services, immunizations, measles and rubella vaccination, and SIAs?	41	45	31	33	41	62	30	32
b. What misconceptions and attitudinal barriers exist among public and private sector health care providers regarding measles- and rubella-containing vaccines?	37	25	15	50	62	23	40	53
f. What are the best strategies to address information gaps or confidence gaps in measles and rubella vaccines in different settings?	35	25	38	0	38	23	50	68
c. What are effective strategies to enable health workers to obtain up-to-date information about the populations in their catchment areas and to understand their attitudes and perceived needs for health services?	32	42	31	50	21	31	40	16
e. What are the primary reasons for low confidence and demand, and high confidence and demand, for immunization in general or for measles and rubella vaccination of specific age groups?	29	21	38	33	45	31	50	11
g. What are suggested methods to increase coverage for the second year of life (2YL) platform and create 2YL vaccine demand?	28	36	38	17	7	23	30	37
h. What are the most effective evidence-based strategies for measles and rubella vaccine acceptance?	22	17	46	33	31	8	0	26
j. What aspects of service delivery impact demand for measles and rubella vaccines?	15	15	23	33	7	15	0	21
i. What are the best methods for assessing confidence and demand interventions for measles and rubella vaccines?	7	9	8	17	7	8	0	0

Table 5b. Significance and urgency of **vaccine demand and communications** research priorities, total and stratified by WHO region.

Vaccine demand and communications research questions	Significance, mean ¹		Urgency, mean ²	Significance, mean ¹						
	Total (n=142)		Total (n=137)	AFR (n=51)	AMR (n=14)	EMR (n=6)	EUR (n=30)	SEAR (n=13)	WPR (n=10)	Global (n=18)
	Mean	SD								
d. How can communities best be engaged in planning, implementing and monitoring health services including vaccinations? What capacity-building is needed for health workers to be able to identify and work more effectively with community leaders?	3.6	0.6	2.6	3.7	3.4	3.7	3.5	3.7	3.5	3.3
f. What are the best strategies to address information gaps or confidence gaps in measles and rubella vaccines in different settings?	3.5	0.7	2.5	3.5	3.4	3.5	3.6	3.4	3.4	3.6
g. What are suggested methods to increase coverage for the second year of life (2YL) platform and create 2YL vaccine demand?	3.5	0.7	2.4	3.6	3.3	3.7	3.2	3.3	3.7	3.5
a. What are community attitudes and perceptions related to health services, immunizations, measles and rubella vaccination, and SIAs?	3.5	0.7	2.5	3.4	3.4	3.5	3.7	3.5	3.4	3.3
c. What are effective strategies to enable health workers to obtain up-to-date information about the populations in their catchment areas and to understand their attitudes and perceived needs for health services?	3.4	0.7	2.4	3.5	3.3	3.8	3.4	3.4	3.6	3.2
h. What are the most effective evidence-based strategies for measles and rubella vaccine acceptance?	3.4	0.7	2.4	3.3	3.6	3.8	3.8	3.2	3.4	3.2
b. What misconceptions and attitudinal barriers exist among public and private sector health care providers regarding measles- and rubella-containing vaccines?	3.4	0.7	2.4	3.4	3.2	3.7	3.5	3.3	3.2	3.4
e. What are the primary reasons for low confidence and demand, and high confidence and demand, for immunization in general or for measles and rubella vaccination of specific age groups?	3.3	0.7	2.3	3.2	3.2	3.5	3.6	3.6	3.3	3.3
j. What aspects of service delivery impact demand for measles and rubella vaccines?	3.3	0.7	2.3	3.3	3.1	3.7	3.5	3.3	3.2	3.2
i. What are the best methods for assessing confidence and demand interventions for measles and rubella vaccines?	3.2	0.7	2.1	3.1	3.2	3.5	3.5	3.2	3.1	3.0

¹ Answers were given the following values: 1=not significant, 2=low significance, 3=moderately significant, 4=highly significant.

² Answers were given the following values: 1=not essential by 2020, 2=by 2020, 3=as soon as possible.

Table 5c. Key additional **vaccine demand and communications** research questions.

	Significance	Urgency
AFR		
Behavior change	High	As soon as possible
More evaluations, including economic evaluations, of SMS alerts for SIAs	High	As soon as possible
More evaluations, including economic evaluations, of SMS reminders for routine	High	As soon as possible
What triggers care takers to return for 2nd dose	High	As soon as possible
What is the mean of the cost of vaccine in private clinics and how this cost should be sponsored and be communicated to the population	High	By 2020
AMR		
To what extent do education-based interventions affect health beliefs, and subsequent behaviours? Or, to what extent does increasing (fact-based) knowledge change (opinion-based) beliefs?	Moderate	By 2020
EUR		
Lack of confidence of the national immunization leadership to require school entry vaccines	High	As soon as possible
lack of global support to the national leadership in requiring school immunizations	High	As soon as possible
SEAR		
massive communication using interpersonal and simple tools for parents	High	As soon as possible
Research on right person on right place (especially in supply chain)	High	As soon as possible
WPR		
GLOBAL		
Novel technology for increasing confidence such as mobile phone apps	High	Not essential by 2020
schools-based immunization promotion	High	Not essential by 2020

Appendix 2. Open-Ended Responses to Implementation Challenges from Web Survey

Table 6a. Main implementation challenges related to **epidemiology and economics** to achieve elimination goals (African Region).

Challenge #1
Accurate assessment of population immunity within countries - very poor coverage and surveillance data make this hard
Achieving and sustaining minimum surveillance performance indicators in all countries to facilitate regional elimination.
adequate rubella surveillance to understand epidemiology
Age distribution of measles and rubella cases
anti-vaccination groups
attitude of health workers to ward's sample collection is very poor
Causes of post measles vaccination outbreaks
Client behaviour change
Correct estimation of population in need/affected
Cost effectiveness of measles vaccination (DRC or Nigeria) can convince government to invest more in preventive activities than outbreaks response
Cost of outbreaks
cost of responding to measles outbreak
country level work on Kimberly Thompson's work, elimination vs. high control
critical vaccination threshold necessary to achieve elimination in different settings
determination of time interval and age groups for SIAs
determine age group
Disease and death averted by current vaccination coverage
Disease manifestation in non-typical age group
Diseases burden analysis and cost benefit analysis of effective vaccination
economic burden of measles and CRS
Establishing the burden of disease (rubella mostly)
Estimation of population immunity through sero-surveys
Financial sustainability implementing campaigns
High drop-out rate between DPT1 and MCV1
How important is waning of measles immunity to achieving and sustaining elimination?
How to better target and vaccinate children to create herds immunity in the population
Information on incidence/prevalence of measles and/or rubella in difficult to reach areas.
insufficient support of surveillance strengthening in non-priority countries
Knowledge gaps for government officers
Lack of funding
Lack of sensitive bedside diagnostic test
Lack of technical staff to support programs and policies
l'age idéal pour l'administration de la 1ère et de la 2ème dose dans un contexte de risque élevé [the ideal age for administration of the 1st and 2nd dose in a high risk environment]
low RI and MR coverage in AFRO
measles surveillance data quality
Open vial policy - use of 10 dose vial
optimal age for measles second dose
other parameters for determining optimal interval between measles SIAs to prevent outbreaks
Poor routine immunization performance
Poorly understood epidemiology of the diseases especially rubella.
Prevalence of rubella among pregnant women
Quality data
R/CRS disease burden evidence generation
Reaching populations not reached by current vaccination strategies (EPI and SIA)

shift in epidemiology of measles cases that now affect older groups
Simplified rapid diagnostic tests at field level for rapid dx
Stock-outs of lab reagents
Surveillance (molecular epidemiology)
Surveillance among vaccine objectors whose children are a source of measles
Sustainable financing of measles/rubella
The burden of rubella and CRS is not well known
Timing of first measles containing vaccine doses
Transmission of disease
Unknown local epidemiology and immunogenicity among local population
valid doses of measles including age at which first dose should be given
Challenge #2
the economic impact is not well appreciated
Campaigns missing large portions of kids not reached via routine
Can adults sustain measles virus transmission in the presence of high child immunity levels thereby making adult vaccination necessary to reach and maintain elimination?
Cost effectiveness of implementation strategies for measles/rubella
Cost effectiveness of rubella containing vaccines compared to measles only vaccines
Cost implications for setting and implementing CRS surveillance
data is not used for action
Data quality issues
describing age distributions of measles/rubella
Determination of the optimum age for the second dose measles
determine geographical zones for outbreak responses
ease of route of administration of vaccine to address equity easily
Economic costs of treatment versus prevention of measles in low income countries
Economic impact of higher MR vaccination coverage
epidemiological susceptibility across various age groups
epidemiology in priority countries
establish the magnitude and incidence of CRS specific to the country
Establishing the economic burden of measles and rubella
Factors leading to outbreak in high coverage communities
Geographical accessibility and utilization
How to get country governments to increase or maintain the investments in immunization to ensure timely supply and vaccination of targeted children
identifying strategies and tools for identifying high risk areas
immunity response
Implementing selectively the important lessons learned from years of research and initiatives on eliminating the barriers to achieving universal vaccination coverage.
improving measles surveillance performance indicators
in AFRO, failure to introduce rubella because of low MCV coverage and additional cost of vaccine
Incidence of disease
interagency and MoH active collaboration and communication on plans and actions taken
Lack of adequate/complete surveillance data
Lack of budget line as an investment of governments in measles and rubella (measles second dose and surveillance budget)
Lack of guidance on outbreaks (invest, response)
Lack of political will & country ownership
les déterminants des épidémies dans les zones à couvertures élevée [the determinants of epidemics in areas with high coverage]
Limitations of sero-epidemiology with current tools for identifying immunity gaps
limited resources to tackle large target population
M/MR country specific costs and investment returns
Material & financial resources e.g. provision of mobility
Missed opportunities for vaccination

molecular epidemiology
Population mapping by EPI program
Prevalence of susceptibles among the population with recurrence of measles outbreaks
Prioritizing immunization especially elimination or eradication of vaccine preventable diseases in budget line items by countries.
Resource mobilisation, financing framework
Responding to measles outbreaks with inadequate funding
role of older children and adults in sustaining measles virus transmission
role of viral seeding, town to country, in maintaining transmission
Surveillance for rubella
Timely funding of SIAs and surveillance/lab activities
Un-updated knowledge on measles and rubella transmission modes in various set ups.
Vaccination before 9 months of age - invalid doses
waning immunity and secondary vaccine failure
wider age distribution in target population
Challenge #3
Accessibility to EPI services by hard to reach communities
Communication gaps at various levels of disease surveillance
Community involvement in measles-rubella elimination strategies
coverage and sero surveys
Economic burden of measles outbreak
Eliminating missed opportunities for vaccination due to vaccine stock-outs, failure to open a multi-dose vial, inadequate HCW training on age eligibility and contra-indications, inadequate public awareness, etc.
Few high quality studies on determinants of vaccination or of cost-effectiveness of different vaccination strategies
getting appropriate micro plan
Government contributions towards staff motivation & development.
High cost of supplementary immunisation activities and financing of the SIA
impact of introduction of MR into routine system and its second dose coverage
implementing CRS sentinel surveillance
Improve models to better measure the buildup of susceptible over time
Inefficient and overlapping information systems
Laboratory capacity
Lack of clear information about disease burden of measles and rubella in Africa countries.
les methodes d'évaluation du risque et du nombre de susceptibles [risk assessment methods and the number of susceptibles]
limited health economics studies to support integrated public health actions or cost effectiveness of interventions
Measles immunity (serology) among population with recurrence of measles outbreaks
Outbreaks
Over dependence on WHO/UNICEF coverage estimates without adequate research on measles and rubella for advocacy and resource mobilization at country and global levels.
Poor or lack of data on congenital rubella syndrome
Predictors of outbreak in a district
Prevention
production of vaccine & supply with affordable finances
Quality SIAs
Reasons for failure to vaccinate
Risk community
risk factors and determinants for measles outbreaks
Robust approach determine the progress
sero-conversion rate following immunization in low resource settings
Sero-epidemiology
surveillance for rubella / measles
sustainable financing of vaccines and supplies
Sustaining high coverage above 95% with some districts facing challenges of access and utilization
the epidemiology of measles

upper age range transmission

Using second year of life for vaccination

vaccine cost

value of serological surveillance

Weakness of surveillance system (lack of active surveillance of measles and rubella especially CRS surveillance)

What is the economic burden of measles outbreaks in low and middle income countries?

Table 6b. Main implementation challenges related to **epidemiology and economics** to achieve elimination goals (Region of the Americas).

Challenge #1
Cost of measles and rubella elimination sustainability
Finance
Human resource
immunization coverage
Manter equipes de vigilância epidemiológica de doenças exantemáticas nas 3 esferas de governo. [Maintain epidemiological surveillance teams of diseases in the three spheres of government.]
Notification of measles and rubella cases in light of arbovirus epidemics (i.e. Zika)
Optimal strategies for outbreak investigation and control
Outbreak response
Role of a focus on measles and rubella elimination in building the overall immunization system
simpler, low cost vaccine e.g. microarray patch
Strategies to increase immunization coverage, targeted to the different needs of distinct population groups
surveillance
The Americas has already eliminated measles and rubella.
Vaccine hesitancy (anti-vaccine movement)
Challenge #2
Epidemiology of suspected measles and rubella cases
field surveillance
Garantir imunobiológicos. [Ensure immunobiologicals.]
Heterogeneity in coverage
Human resource with required competence
Lack of knowledge
Long term global funding for MR programs
Political engagement
Poor surveillance
Population immunity
Review of national coverage
sensitivity and specificity of rapid MR test kits
simple, low cost rapid tests for M and R
Challenge #3
Adequate infrastructure and finance
convincing cost benefit case for eradication
Garantir capacidade laboratorial. [Ensure laboratory capacity.]
Human resource
level of waning of immunity to measles from vaccination after age 6 years
Measures/indicators to track progress for measles and rubella sustainability
Pretravel recommendations implementation
Seroepidemiology
Survey of measles refusals
vaccine doses

Table 6c. Main implementation challenges related to **epidemiology and economics** to achieve elimination goals (Eastern Mediterranean Region).

Challenge #1
Active and case based surveillance system
difficult to reach areas
middle income country affordability (entire program and not just new vaccines)
Reach to the unreachable children
Role of private sector in vaccination and best approaches to involve private doctors
Understanding the level of susceptibility of older adolescent/adult populations and whether this susceptibility is really important in sustaining transmission
week of surveillance
Challenge #2
Coverage data and its quality
Effective surveillance
middle income health and immunization systems fragility and fiscal capacity
Molecular characterization of viruses
Surveillance power and activities
Under appreciation of policy makers about high cost of outbreaks and cost benefit of good surveillance and vaccination
Insecurity, difficulty in delivering vaccines in some areas
Challenge #3
Coverage of routine immunization
Increase the routine MCV coverage
sharing of private sector in the activities of elimination
inability to procure vaccines
waning immunity

Table 6d. Main implementation challenges related to **epidemiology and economics** to achieve elimination goals (European Region).

Challenge #1
Achievements against existing resources (human and financial)
Cases of outbreaks and molecular epidemiology
Development of good vaccination registries and good knowledge of vaccination gaps in every country
dissemination of current epidemiology measles and rubella indicators among professionals
Documentation of transmission patterns esp. of rubella
Economic estimate impact of M, R and CRS
Education of the population
Greater involvement in the identification of susceptible groups
Homogenization of vaccination recommendation in the different European countries
Identification of high risk groups for measles infection in countries with high vaccine coverage
Identification of immunity gaps
Identify the reasons for MMR vaccination refusal in the general population
Improvement of laboratory diagnostics (algorithms for refinement and re-infection classification, point-of-care tests)
Lack of national support for MR elimination despite strong epi evidence
large vaccine coverage
Main challenge in Denmark is to increase MMR vaccine uptake
molecular epidemiology
monitor measles and rubella viruses transmission
Our major challenge is the high number of countries with their own legislation. Not something that can be addressed by research.
Rate of discarded cases 2/100,000 difficult to assess for several countries
Reach special risk populations (Roma, travelers, refugees...)
Refusal to vaccinate
Strength of surveillance system
Surveys to find susceptible age groups
To eliminate endemic measles and deaths from measles
to ensure financial support for procurement vaccine for required quantity
Vaccination coverage - closing gaps
Vaccine hesitancy, concerns on vaccine safety, lack of trust in research findings
Vaccine uptake in hard to access populations
Weak surveillance in places
What is the need to vaccinate older children, adolescents, and adults in supplemental immunization activities
Challenge #2
acceptance of vaccines by the public
Adult vaccination policies - free of charge
Calculate costs per case of imported measles including contact tracing etc as this might well surprise the population and increase their feeling of social responsibility towards vaccination of their own children
characterisation of measles and rubella infection in fully immunised individuals
Closing immunity gaps by SIAs
collaboration between clinicians, laboratory and epi staff
Control nosocomial transmission
diagnosis
False contraindications (anemia, hemangioma, encephalopathy, etc)
How to deal with rubella disease characteristics re surveillance
Identify the populations for which immunization campaigns should be implemented
identify the susceptible group of population to measles/rubella
Impact of nosocomial transmission
Improve measles, rubella epidemiological surveillance
Improve vaccination coverage
Improvement of surveillance quality
Insufficient funding for carrying out serosurveys

lack of national interests even when economic issues are provided
Lack of rapid laboratory diagnostics, therefore delayed response
Middle income country financing
Monitoring and timely determination of the causes of susceptible groups' occurrence.
Need of effective SIAs among (young) adult population
Research of outbreak responses in different countries
Serosurvey studies
strengthened sero-epidemiological surveillance
strengthening communication mechanism regarding to get up immunization coverage rate over 95% with MR vaccine
Surrogates of discarded cases for rubella in the absence of a discarded cases notification system
Vaccination
What are the epidemiologic characteristics of measles (e.g., incidence, age distribution, case fatality ratios) in various settings in priority countries
Challenge #3
adults immunization
Bad communication strategies
Breakthrough measles cases after 1 or 2 doses: protection waning or primary failure?
Comparison of outbreak and vaccination cost studies
Cost of false commitments 2000 to 2015
create a surveillance system on measles & rubella after their elimination
Epidemiological characteristics of measles and rubella
Establish causes of re-emergence on highly developed countries
Estimation of underreporting of rubella cases
Financial implication of outbreaks/cases
genotyping
Health care professionals who are providing vaccination service against measles and rubella can be paid extra from the health insurance fund.
Improved interaction between public health management and laboratory diagnosis
Improvement of vaccine stability and delivery systems
Maintain sustainable high coverage
Modelling of outbreak risk in areas of low coverage
Motivation of medical staff
prevalence of M & R susceptibility - seroprevalence study
providing resources for laboratory diagnostics
Public communication campaign for increasing the awareness of measles and rubella vaccination
Seroprevalence study to identify susceptible individuals, risk groups
strengthen childhood immunization programmes
The most fundamental issue to MR goals is buy in. There is a lack of national support for MR goals.
What are the best methods to estimate the threshold population size and susceptible density required to sustain measles and/or rubella virus transmission in various settings?

Table 6e. Main implementation challenges related to **epidemiology and economics** to achieve elimination goals (South-East Asia Region).

Challenge #1
accumulation of susceptible infants even after achieving high coverage among target groups
case based surveillance expansion (to include peripheral health facilities)
Case investigation due to geographic difficulty
coverage versus immunity
Exact epidemiology is not known.
Measles burden in the country
Non-inclusion of all age groups in vaccination programs
population immunity
Reaching hard to reach implementation research
Regional variations in the country
right age of vaccination
Surveillance
threshold for non-measles non-rubella discard cases in the population
transport
Challenge #2
adult vaccination
appropriate vaccination schedule
communication
cost effectiveness of SIAs
Cost of single and combined vaccines
Laboratory, lack of reagent
Measles seroprevalence
Reaching every child with 2 doses of MCV
reemergence in countries with high MCV coverage
regular identification of population categories susceptible as with advancing vaccination coverage with 2 doses
Sample collection and shipment
Selection of optimal age for MCV1 and MCV2
Serosurvey
some areas have low measles coverage
Challenge #3
alternative sample collection
Developing robust and innovative surveillance system
Financial
High risk groups
Outbreaks in areas with high vaccination coverage
point of care testing devices for rapid diagnosis and action
possible future implications of MMR 1 vaccination before 1 year of age (at 9 months)
reaching the difficult population
Rubella vaccination is not yet part of routine immunization program
security
Serology survey
Sustaining partnership for the resource and advocacy
Timing of vaccines

Table 6f. Main implementation challenges related to **epidemiology and economics** to achieve elimination goals (Western Pacific Region).

Challenge #1
Affordability of relatively expensive IgM ELISA kits
Analysis of vaccine/program efficacy by serosurvey
identification of vaccination target population (unestablished birth registration in some countries)
identifying and closing immunity gaps
Lack of clear data on disease burden
Lack of funding
molecular epidemiology in resource limited settings
population immunity survey
Reaching migrant children
safety and efficacy of MR vaccination at 6 to 9 months of age
Weak surveillance
Challenge #2
Adult susceptibility
Assessment of gaps between high vaccination coverage and continuing large outbreaks in some countries
CRS surveillance standards for lab & case classification and performance indicators
immunity status among urban slums
Lack of staff
Poor linkage between surveillance and response
true impact of waning maternal immunity
vaccination of women pre-pregnancy to protect <6 months
vaccination to unvaccinated adult population
Weak surveillance system in some countries
Challenge #3
Assessment of appropriateness of vaccine usage/delivery/storage and cold-chain conditions
cost effective strategies for adult populations
cost of outbreak versus routine MMR coverage
globalization of economy including enhancing movement of people
Lack of coordination during outbreak response
Lack of political will
need for adult booster doses where there is sub-optimal coverage legacy
nosocomial transmission

Table 6g. Main implementation challenges related to **epidemiology and economics** to achieve elimination goals (Global Level).

Challenge #1
Better understanding of economic trade-offs when deciding on vaccine delivery strategy (e.g. campaigns / routine; fixed / outreach; PIRI etc.)
Costs and cost-effectiveness of different strategies for reaching hard-to-reach/chronically missed children
high-quality disease surveillance
Identification of at-risk populations to target (age, geography, etc.)
identifying population immunity gaps
Implementation in resource poor countries
Issues relating to sustaining elimination including waning maternal and population immunity
limited resources and political will
Making the case for eradication of measles and rubella
Making the economic argument for measles and rubella elimination
Obtaining molecular epidemiological data
Poor health systems/lack of funding and infrastructure
role of adolescents and adults in persistent measles and rubella transmission
surveillance quality
Sustainability of financing for immunization
What is the effect of performance based financing in reaching measles and rubella goals?
Challenge #2
appropriate strategies to fill immunization gaps
Better approaches to reaching marginalized groups including measuring coverage more accurately and using novel technology (e.g. apps)
Country level data
expanded assessment of value of measles/rubella elimination
Financing/budget impact analyses/return on investment for rubella and measles second dose introduction and coverage scale up
full-cost accounting of immunization and treatment in low and lower-middle income countries
How to deliver MCV1 more effectively economically and to have maximum epidemiological impact
inadequate SIA quality
Obtaining complete surveillance data
Reaching children beyond 9m visit
reaching the chronically unvaccinated and undervaccinated children
role of infants in measles and rubella virus transmission
Vaccination response to changing epidemiology of measles affecting infants and adults
What is the effect of vouchers and/or cash transfers on reaching measles and rubella goals?
Challenge #3
Comparing cost effectiveness of measles versus new vaccines
Complementarity/tradeoffs/optimization of interventions to strengthen RI vs SIAs/campaigns
creating expectations for high-performance on MR in the absence of a global mandate, monitoring, and accountability
In country capacity
inadequate surveillance
Obtaining complete laboratory diagnostic data
optimal methods for CRS surveillance
Policy research on effective advocacy for eradication to reduce costs in the Americas from importations and cost ineffective outbreak response
Surveillance and outbreak response
What is the coverage threshold for a "paradoxical effect for rubella/CRS"?

Table 7a. Main implementation challenges related to **new tools for surveillance, vaccine delivery, and laboratory testing** to achieve elimination goals (African Region).

Challenge #1
Acceptance/mandate to use tools; Training and accompaniment to optimize use of tools
Alternative vaccine delivery systems
availability of kits for laboratory testing and confirmation
Can affordable diagnostic tests be developed to rapidly and accurately confirm measles and rubella cases at the point of care?
Clear definition of measles outbreak in different settings
clear surveillance case definition for rubella and frequently changing tools
commitment of health workers
Countries ownership
Delayed laboratory results due to inadequate number of laboratories used.
determining the time interval between campaigns to maintain population immunity
Do the 2 doses give lifelong protection
easier measles immunizations technologies for hard to reach populations e.g. microarray patches
electronic capturing and monitoring tool
Expertise
Functional laboratories in each country for early confirmation of cases for early epidemic response
Funding
health worker capacity
How readily available and user friendly are the existing surveillance tools?
human resources
Inadequate training and supervision
Laboratory confirmation of cases - need of point of care diagnostics
lack of rapid diagnostic bedside test
Low cost rapid diagnostic tools
Need point of care diagnostics for measles and rubella that ideally can be used by community health workers or equivalent
new diagnostic tests, using noninvasive methods
Non-needle thermostable vaccine (patch)
optimizing schedule for measles second dose
Point of care measles and rubella IgM test
Preparing to go to scale with micro-needle patch vaccination delivery.
Rapid testing for field to make prompt diagnosis
Rapid tests diagnostics kits
Reaching older children with at least 2 doses of vaccine
Resistance to change or adoption of new tools
scarcity of electronic work friendly surveillance tools
Surveillance based of oral fluid or throat swabs collection
surveillance for rubella
tests rapides de diagnostic [Rapid diagnostic tests]
the potential use of technology and GIS mapping in measles surveillance
Tools with less information to be captured at operational level
Transportation of blood specimen from health centers to the laboratories is a challenge
Unavailability of point of care tests kits for measles - the current method has long turn-around time
Use of rapid diagnostic test kits at the district level
Weak and poorly staffed country EPI team
WHO surveillance tools are not decentralised up to the lower level (especially data analysis tool)
Challenge #2
Absence of system to remind mothers to come back for immunization (Big interval between 14 weeks and 9 months. There is also big interval between MCV1 and MCV2. There should be an sms system to remind mothers.)
accountability across cadres of health delivery
Alternative to current requirement for injection of reconstituted vaccine necessitating cold chain and skilled HCW
Availability of laboratory capable for testing and testing kits for measles rubella

cheap rapid test for measles and rubella dx
Cold chain
Data quality
determining reasons for under- and non-reporting of measles cases
Developing highly sensitive risk assessment tools
Human resources availability
Inaccessibility to vaccines to some unprivileged population groups.
Inadequate cold chain
Ineffective vaccine delivery systems leading to stock-out at the health centers
Innovative surveillance methods
Integration and triangulation among them, check tool
Is measles vaccine wastage rate a factor in missed opportunities?
Is there a quicker and cheaper way for testing for IgM antibodies
lack monitoring and supervision
Lack of knowledge on measles surveillance especially case definitions
lack of microvaccine patches
low RI coverage
Low support from central governments
Lower doses (5) vials
Microneedle patches to deliver measles and rubella vaccines
Need better understanding of how to motivate health workers to improve reporting and to use data better for program planning
No new surveillance tools and use of more efficient technology for surveillance information system
Poor vaccine supply chain management skills
Potency of vaccines in short time after being diluted
Preparing to go to scale with blood spot and oral fluid for lab diagnosis.
Prévisions for implementing necessary corrective actions
rapid diagnostic and affordable tests at operational level
Resources (financial)
Sequencing (virus gene)
serosurveys as a planning and management tool
Storage of measles vaccine out of cold chain
the lack of MCV vials of smaller number of doses impeding opening vials for each child at service delivery point
vaccine availability for routine immunization activities
vaccins plus facile à utiliser (hors CDF, sans injection...) [Vaccines easier to use (without CDF, without injection ...)]
well organized vaccine delivery system
What is the best way to do subnational vaccine distribution outside administrative boundaries?
What is the most appropriate method for determining level of population immunity in developing countries?
Challenge #3
alternative delivery methods (thermostable, micropatch etc)
availability of functional community based structures to detect measles outbreaks
Can tests be developed to accurately measure neutralizing antibodies to measles and rubella viruses, and provide results faster than the plaque reduction neutralization assay (PRNT)
Coverage for second dose
Developing rapid assessment tools
determining thresholds for herd immunity in different settings
Does batching of measles serum samples contribute to false negatives hence undetected outbreaks?
How best can surveillance samples be referred to testing for quick results?
huge difference in level of understanding for the tools
identifying obstacles to rapid organization of response campaigns during outbreaks
Improved lab methods for sero-epidemiological studies especially in settings where measles antibody levels are low or have waned
Inadequate fund to ensure effective surveillance of measles and/or rubella in all geographical areas.
indicateurs de performances de la surveillance [surveillance performance indicators]
laboratory reagents cost

Lack of coordination at various levels
lack of financial support for monitoring and supervision
need for field lab testing for measles and rubella
poor surveillance for measles and rubella and CRS
Poor understanding of surveillance indicators
Quantification of laboratory reagents and its management
Rapid low-skill confirmatory testing (thus eliminating need for all samples to be shipped to centralized location)
Rapid test and non-invasive lab tests
Resource (logistics)
Risk assessment tool not user friendly
Routine genotyping to further elucidate the epidemiology
simple and easily available testing kits
Stock-out of reagents at laboratories
sustainable and equitable financing
vial with less than 10 doses to reduce wastage rate
Weak support for HR capacity building on SMT and logistics of vaccines and vaccination materials
Weak surveillance systems

Table 7b. Main implementation challenges related to **new tools for surveillance, vaccine delivery, and laboratory testing** to achieve elimination goals (Region of the Americas).

Challenge #1
Capacitação de profissionais de vigilância epidemiológica e laboratório. [Training of epidemiological and laboratory surveillance professionals.]
cost
Development of new molecular tools for viral surveillance and molecular epidemiology
Human resource
Immunity prevalence
immunization coverage
Knowledge, attitudes and beliefs of public re: vaccination (i.e. ability to actually deliver the program/product)
Maintenance of the cold chain and the wastage from multidose MMR vials
Regulatory barriers
Training
vaccine delivery in areas of under-immunization
What are the performance surveillance indicators to measure sustainability of measles and rubella elimination?
Challenge #2
Alternative methods for vaccine delivery (e.g. microneedle patch)
building capacity
Diagnosticar diferencial conforme cenário epidemiológico vigente. [Diagnose differentially according to the current epidemiological scenario.]
Equipment
Extended molecular surveillance
Finance
laboratory testing during outbreaks
number of doses
sensitivity and specificity of point of care MR rapid test kits
Thermal stability
What are the performance vaccination indicators to measure sustainability of measles and rubella elimination?
Challenge #3
age of vaccination doses
Capacity of workforce to complete testing (i.e. too many specimens for current amount of staff)
Cost
Facility
Garantia de imunobiológicos. [Guarantee of immunobiologicals.]
identification of source of measles or importations
sustaining quality

Table 7c. Main implementation challenges related to **new tools for surveillance, vaccine delivery, and laboratory testing** to achieve elimination goals (Eastern Mediterranean Region).

Challenge #1
Active and case based surveillance
availability of pre-qualified labs
Difficulty of delivering injectable vaccine in large scale campaigns
outreach activities
Vaccine delivery in conflict affected areas
Very strict conditions at MOH to accept vaccines from un-registered companies even if they are pre-qualified by WH
Challenge #2
best strategies for surveillance and possibility to involve community
Maintaining cold chain for vaccine delivery
No clear estimated target for under 5 children in HTR & BSG areas
presence of supportive supervision
Trained staff and effective cold chain
Challenge #3
Cooperation of the private sector for surveillance
Rapid diagnostic tests
specimen transportation
The road blockade affecting vaccine delivery

Table 7d. Main implementation challenges related to **new tools for surveillance, vaccine delivery, and laboratory testing** to achieve elimination goals (European Region).

Challenge #1
Absence of new tools for surveillance of measles and rubella
AEFI surveillance measures important in keep coverage rate
Assays to more accurately determine protection against measles and rubella
Define vaccination / immunity gaps in the region
Development of clear laboratory algorithms for different laboratory settings
Effectiveness of vaccines
e-registers development
Further developing of point of care tests
Higher vaccine coverage
Implementation of Informational Immunisation System (electronic)
Improving surveillance quality
In my opinion, achievement of regional MR elimination in the European region is not restricted by lack of tools for surveillance, vaccine delivery and lab testing.
Lack of electronic surveillance (lot of paper work)
Lack of human resources involved in surveillance activity
Lack of national support
Methods for rubella surveillance
Modelling methods in surveillance
More user friendly methods for rubella genotyping
Organization of united reporting database for case and monthly reports
PCR detection
reach a high level of notification rate
Thermostable and easy to use new vaccine delivery platforms
to ensure laboratory confirmation of suspected M/R cases
To improve the sensitivity of the surveillance (rising the number of suspected cases investigated)
To interrupt measles, rubella transmission in low, middle income countries and large geographic area for a prolonged period of time
ways to increase immunization coverage from 60-65% to 95% for two doses
What is the effectiveness of two or more doses of measles-containing vaccine for achieving elimination in high birth rate densely populated settings in developing countries?
Challenge #2
Adolescent and adult vaccination platforms and mobilise political support for free of charge
availability of a stock of vaccine for those who should be vaccinated in the next year
Care should be taken to ensure appropriate storage conditions during MMR vaccine transportation (cold chain)
delivery of vaccine on time to not disturb the immunization program
Developing efficient genotyping methods on sera
Development of accurate oral fluid based serological assays to confirm recent measles and rubella infection
Development of reliable rapid diagnostics and multiplexes for differential diagnostic
Distrust of population in vaccine safety evidence (vaccine safety concerns)
Faster and more efficient surveillance
genotyping
Implement adequate but low-cost measles serology for population-based immunity screening
Increase number of laboratory testing of suspected cases
Lack of money globally
Lack of regional office pressure on national governments
measles, rubella and RNaseP multiplex for molecular examination
Outbreak investigations
reach a high level of microbiological confirmation rate
Role of vaccinated individuals in measles transmission
standardisation of surveillance methods and data collection
to define age groups and ensure high quality of vaccine delivery
To improve the integration of epidemiological and laboratory data.

virus detection and genotyping is costly for the surveillance system

What is the most appropriate method for determining level of population immunity in developing countries?

Challenge #3

during a low incidence of active virus, simultaneous sampling of specimens for the serologic diagnosis and genotyping

Enhancing the case-based surveillance

Ensure that a diagnostic test would be developed to rapidly and accurately confirm measles and rubella cases.

Faster ensurance of the appropriate samples for laboratory testing

Improving reporting and indicators

Lack of personnel

Lack of rapid diagnostics means (ELISA is challenged and not available in all levels)

Not all children are reached by GP to receive MMR vaccine

routine use of molecular tests

Sequencing protocols to identify transmission routes

Studying different vaccination systems to develop good guidance

The region knows what to do to reach elimination, they don't have the support of member countries

to develop a rapid and accurate test to confirm measles and rubella cases at the primary sector health

to develop active surveillance for M/R

To develop more powerful markers for molecular epidemiology.

What are valid performance indicators for measles and rubella case-based surveillance in different settings?

Table 7e. Main implementation challenges related to **new tools for surveillance, vaccine delivery, and laboratory testing** to achieve elimination goals (South-East Asia Region).

Challenge #1
Access of reliable test to confirm disease at district level or equivalent
alternative method of laboratory testing - serum
CRS surveillance
Definition must be broadened to increase the sensitivity
easy reliable methods for sample collection at field level
Hard to reach population, maintenance of cold chain
lack of point of care testing device for rapid response to a confirmed case of measles
Need for infrastructure
POCT needed for point of care testing for rapid confirmation of measles cases
Population coverage
quick and effective laboratory tests
Sample collection and shipment (dried blood spot or oral fluid)
transport
Challenge #2
challenge with case definition - rash and fever
Cold chain and vaccine transport system
communication
Cost
easy giving vaccines
Injectable route of vaccine administration
lack of skilled providers to provide injectable vaccine specially in campaigns
New tools for vaccination (patch system for immunization)
No reliable indicators for the quality of case based measles surveillance
outbreak surveillance
Training of health workers
unavailability of rapid, reliable diagnostic methods to be used at point of care or field level
uninterrupted supply of vaccine
Challenge #3
Administrative and political challenges
Availability of resources
IEC activities
improving surveillance and reporting
Innovative training method to health workers for surveillance
Lack of/weak laboratory facilities in resource limited settings
New quick method of diagnosis
new technologies for laboratory test
security
surveillance performance indicators for measuring progress

Table 7f. Main implementation challenges related to **new tools for surveillance, vaccine delivery, and laboratory testing** to achieve elimination goals (Western Pacific Region).

Challenge #1
Lack of rapid test for measles and rubella suspect cases that can be used at the service delivery level
method for serosurvey
Micro-array patch effectiveness trials
micro-array patches
point of care testing for measles and rubella
precise data on the population, list of names of the eligible children, etc.
Challenge #2
cold chain maintenance during delivery and proper use of vaccines
Low utilization of mobile phone technology in surveillance e.g. to report suspect cases
MR vaccine patches
Rapid field sero-immunity tools
vaccine storage and transportation
zero dose MR in high risk settings
Challenge #3
access to the eligible children
Development of easy and inexpensive POC testing
Innovative e-surveillance
mobile phone methods of surveillance reporting
sensitivity of PCR vs IgM serological testing

Table 7g. Main implementation challenges related to **new tools for surveillance, vaccine delivery, and laboratory testing** to achieve elimination goals (Global Level).

Challenge #1
Augmented implementation
Cost of laboratory testing
cost of surveillance
Costs and cost-effectiveness of microneedle patch
difficulties finding CRS
Lack of awareness of and use of new diagnostics (widespread)
Lack of funding for tools and training
new methods for lab diagnosis including point of care testing
POC testing
preventing fragmentation of approaches and need to harmonize with other disease initiatives
Rapid field/point of care test for acute disease
reaching populations in areas where maintaining the cold chain is a challenge
Research to incorporate communication across data platforms
test to differentiate disease-induced and vaccine-induced antibodies
Using DBS for routine surveillance
vaccine hesitancy
What are the best point of care diagnostics for measles and rubella?
Challenge #2
Assignment of priority
attribution versus contribution to health systems strengthening
coverage quality data
delays in diagnosis and action due to lack of cheap and effective point of care diagnostics
Ease of specimen collection and transport
easier vaccine delivery systems
new methods to measure seroprevalence
on-site rapid diagnostic tests for measles/rubella using oral fluids
Point of care testing
Problems with specimen transport compounded by having inadequate number of laboratories (Sri Lanka, Myanmar)
rapid diagnostics
Rapid field/point of care test for immunity
reaching subpopulations missed by EPI
Staff turnover
What innovative vaccine delivery methods could substantially decrease the resources needed to deliver measles and rubella vaccines?
Challenge #3
Availability of funding
Effective vaccine management
identification of cases
lack of high-quality and cost-effective rapid diagnostic tests
microneedle vaccine acceptability and effectiveness
new methods to enhance resolution of molecular epidemiology
reluctance of some disease specific programs to engage broader health systems planners - leading to low ownership and decreased sustainability
Vaccine delivery method that can be administered house-to-house by volunteers

Table 8a. Main implementation challenges related to **immunization strategies and outbreak response** to achieve elimination goals (African Region).

Challenge #1
age limit for provision of second dose of measles rubella
break of cold chain
Cold chain
Cold chain management
cost of averting outbreaks through routine immunisation VERSUS SIA
Countries ownership
Describing reasons for poor response to outbreaks
Ensuring potency of the vaccine at delivery point
Establishing effective mechanisms to prevent vaccine stock-outs, learning lessons from the food and drink industry.
evaluating use of SIA preparedness tools
Funding support for outbreak response not prioritised in annual immunization strategic plans
Geographical inaccessibility
Global strategies not always adapted to the particular context
health workers not motivated and overwhelmed
hesitancy to open a vial for few number of children
High costs for conducting SIAs.
How to create an integrated platform in second year of life
how to increase MCV1 coverage
How to reach populations that are highly mobile (nomadic, pastoral etc.)
implementation of outreach due to limited resources
improving MCV1 and MCV2 coverage
Infrastructure issues
Insufficient community engagement in planning, implementing and monitoring vaccination services
Invalid doses
Lack of appropriate job aides for peripheral staff
lack of heat stable, microneedle patch
Low vaccine management capacity resulting in e.g. stockouts
maintaining vaccine security and potency
Measles rubella activities managed and organised as stand-alone intervention
measles second dose: optimizing schedule, strategies to improve coverage
More thermostable vaccines
Not adhering to standard guidelines (REC strategy implementation) not full component is implemented
Poor quality preventative SIAs
Poor utilisation/inadequate resources especially at lower level.
Proper timely planning
Purchasing of cold vans to enhance effective vaccine supplies
stratégies pour atteindre les populations difficiles d'accès [strategies to reach hard-to-reach populations]
Strategies targeting children beyond one year not well understood
Strategies to increase measles second dose
the lack of smaller dose vials, and reluctance to open 10 dose vials for few children
To set up outreach sessions in the community, the EPI has become bigger with many antigens, integration with other services like LLINs, deworming, Vit A supplementation (the main challenge is resources; both financial and human)
Transport for delivery of vaccines
vaccine vial size, public awareness
What are effective strategies for increasing coverage of the second dose given after the first year of life
What is the acceptable wastage rate in different settings that can be used by health facilities in vaccine forecasting
What is the best way to integrate RED planning in routine planning?
Challenge #2
ability to categorize outbreak and magnitude of required response
Adequate skilled human resources
Building capabilities of nationals at various levels to enhance functionality
Cold chain

Community values for immunization / behaviour change
Data management especially denominator issues
Data on population distribution and migration not used enough to plan services
Delay in vaccine delivery
Delayed OB response activities
determinants of outbreak
Determining reasons for stagnant routine MCV1 and low MCV2 coverage
Effective microplanning to improve coverage
Hard to reach populations in the urban settings
Health worker capacity
High drop-out rate
High vaccine wastage rate with the current 10 dose vials resulting in batching of clients and missed opportunities
How can routine immunization denominators be improved to capture every child in their catchment area
how to increase MCV2 coverage
identifying and reaching children missed in routine service and in SIAs
Impact of a legal framework, including school entry requirement to improve coverage
Implementing selectively lessons learned from the WHO/PATH Optimize project, specifically those related to supply chains and logistics.
importance and significance of outbreak response immunization
improving role of private providers in vaccine delivery
improving technologies for use in emergencies, fragile states etc.
insensitive for health workers
Integration of services
Lack of vaccines at health center level
missed opportunities
Not having rapid testing to confirm suspected cases in the field against limited reagents discourages notification of suspected case, delay of diagnosis and action
poor microplanning
poor planning and implementation of immunisation activities
Poor timing of outbreak responses
Quality microplanning at operational level
roll out of an effective outbreak response plan
Shortages of gas for fridges to maintain cold chain
Stockouts of vaccines due to poor funding of routine immunization programs
stratégies pour atteindre et maintenir des couvertures élevées pour les 2 doses chez les nourrissons [strategies for achieving and maintaining high coverage for both doses in infants]
The effectiveness of vaccination during outbreaks
Unreliable data for measuring coverages
Vaccine storage capacity at lower level as many antigens in routine
ways to improve MCV2 coverage
weak surveillance for measles and other VPDs
What are the most cost-effective strategies for outbreak response immunization activities, including the timing of outbreak response immunization and selection of target populations?
What is the region specific quickest way of responding to outbreaks?
Challenge #3
Attaining elimination in middle income countries
capacity of early identification of the index case
Centralization of lab testing
Conducting serological serosurveys to better understand population immunity
Delay in outbreak notification, investigation & response
financial constraints for conducting outbreak investigation and response activities
Hard to reach populations
how to best measure MCV1 and MCV2 coverage
Human resources is challenging in outbreak investigation, turnover of trained staffs in some settings
Inadequate funding for co-financing leading to vaccine shortages

issue of transport

Laboratory services

lack of knowledge and expertise

Limited accessibility (geographical, socioeconomic.....)

Low morale of vaccination service providers.

mécanismes pour une réponse rapide et adaptée en cas de flambée [mechanisms for rapid response in the event of an outbreak]

mechanism in addressing mobile and nomadic population

Not being innovative in trying new strategies

Outbreak preparation and response capacities

overall improvement in RI

political commitment

Poor quality administrative reporting systems

Preparing to go to scale with bar-coding vaccines and injection supplies and monitoring distribution and consumption using digital technology.

Regular supply of vaccines and logistics

Reluctance to declare outbreaks by MoH

school based screening and vaccination

social cultural barriers within the communities

Support through infrastructural development e.g. emergency centers, cold stores etc.

sustaining high vaccination coverage LMIC

ways to reduce nosocomial transmission

Weak logistics and information system for delivery of routine immunization vaccines at all levels of the health system

What are effective strategies to create a motivated and knowledgeable healthcare workforce equipped to routinely administer MCV (e.g., supervision, cash incentives, peer to peer benchmarking, etc.)?

What is the role of governments in outbreak response cost

Table 8b. Main implementation challenges related to **immunization strategies and outbreak response** to achieve elimination goals (Region of the Americas).

Challenge #1
building immunization capacity
Data analysis of vaccination coverage by the local level
Human resources
Implantação do sistema nominal de registro de dose. [Implementation of a vaccine dose registration system.]
KAB of public re: vaccines
strategies to reach and vaccinate hard to reach populations
The impact of a focus on measles and rubella elimination in enhancing the overall immunization system
vaccination age
Vaccine hesitancy
vaccine refusal to routine immunization
Challenge #2
cost
diversity of groups where outbreaks occur and acceptance of vaccine
Finance
How to implement high-quality SIAs
immunization area to interrupted
Monitoramento rápido de cobertura vacinal eficaz. [Rapid monitoring of effective vaccination coverage.]
Political engagement
regional and national coordination of outbreak responses
strategies to improve coverage for MCV2
Will a focus on measles and rubella elimination adversely impact the ongoing immunization system
Challenge #3
Detailed outbreak investigation to guide vaccination activities (particularly regarding vaccination of contacts)
How to overcome vaccine hesitancy
immunization coverage
Infrastructure
monitoring of vaccine coverage
sustaining supervision and quality

Table 8c. Main implementation challenges related to **immunization strategies and outbreak response** to achieve elimination goals (Eastern Mediterranean Region).

Challenge #1
Achieving and sustaining uniform high MCV coverage
demand for vaccines
Effective social mobilization
hard-to-reach populations
procurement of vaccine in crises
Vaccine as part of national routine immunization
Challenge #2
Achieving high SIA coverage
Highly trained peripheral level immunization staff
National immunization team will response on outbreak
outbreak response
strategies for outbreak response
inaccessible areas
Challenge #3
Availability of vaccine
Difficulty of evaluating SIA coverage, need a timely, less costly methodology
Trained staff to understand the importance of cold chain proper vaccine administration
health systems issues
low coverage

Table 8d. Main implementation challenges related to **immunization strategies and outbreak response** to achieve elimination goals (European Region).

Challenge #1
Achieve and sustain very high (>95%) coverage with two doses of measles and rubella vaccines in every district
Adult/adolescent vaccination
Are the protocol according to which we have to vaccinate all the measles case contacts during the first 72 hours really "works"?
Challenges related to population continuous migration
Develop an adult vaccination schedule
Evaluate vaccination campaigns and on this basis plan improvements
how to improve the administration of the first dose at 12 months
Improve communication strategies
improve the childhood immunization programme in countries with suboptimal vaccine coverage in the region
Improved vaccination of the hard to access groups
lack of national support
MMR vaccine is acquired by MoH
Motivation of medical staff
Overcoming vaccine hesitancy
participation of researchers in public debates with anti-immunization lobby
rapid alert system
Regular serosurveys for assessing the real coverage/susceptibility
rejection of vaccination of some groups of people
shortage of funds for procurement of refrigerators
SIA in schools
Strategies to estimate vaccination gaps in different age groups
Strongly recommend MMR vaccination at national, regional and local level
To cover vaccination gaps in adult population
to determine the false contraindication to immunization
vaccination recommendations
Vaccine hesitancy issues
Challenge #2
acceptability of catch up vaccination campaigns
Adult vaccination free of charge
availability of vaccines for adults
Challenges related to poor legislation on vaccine delivery (mandatory or voluntary?)
communication between different actors (laboratory, health inspectors, treating MD, authorities)
delivery of vaccines
Education of the population
Human resources in MR elimination programme
Increase vigilance of medical staff
Increasing the coverage by further motivating health care workers
Introduction of unique patient identifier to track vaccine uptake
Lack of high level advocacy visits to countries
MMR vaccine delivery on time to the local level based on the required needs
Modeling to assess possible impacts of different national or regional vaccination campaigns
Outbreak response (non SIA)
Provide measles and rubella vaccination opportunities, including supplementary immunization activities to all population groups and especially for persons who are susceptible to measles, rubella.
provide SIAs for known risk groups in the region
Research the possibilities of advocacy for vaccination in countries that are close to elimination
shortage of vaccines for outbreak response
to educate the population related to immunization and report the first signs of AEFI
to ensure high quality stabilizers and cold chain for the vaccine delivery
To immunize every sanitary worker
vaccination mandatory

Vaccine hesitancy

Challenge #3

Anti-vaccinist movements

Developing methods to motivate HCVs for vaccination promotion

Elimination goal apathy

e-registry

how to reach low vaccinated populations

immunization of health care workers

implementation of WHO recommendation

In outbreak catch-up vaccination campaign in a defined containment area

Investment in equipment

outbreak response

to detect cases of M/R importation resulted in outbreak of small cases among minimal susceptible population

To improve vaccination coverage on high risk populations (Roma, travelers, refugees)

Table 8e. Main implementation challenges related to **immunization strategies and outbreak response** to achieve elimination goals (South-East Asia Region).

Challenge #1
Cost of vaccines
Coverage of MCV2
Coverage of MRCV1 and MRCV2 >95%
Innovative method to sustain high routine immunization
lack of skilled providers to provide injectable vaccine
Late reporting of the outbreak
Management of vaccine management
reaching children in migratory population, conflict area and peri-urban
sustaining immunization coverage
the dosage schedule
transport
Challenge #2
Better monitoring method to record, report and respond to AEFI
cold chain maintaining
Infrastructure
Missed opportunities
No proper investigation is done
outbreak response
Outbreak response guideline, response to every single case? at what stage?
Ownership by efficient manager (right person at right place)
poor cold chain capacity
training
Vaccine delivery
Challenge #3
Delegation to respond immediately after outbreak
immunization implementation
Increasing coverage - coverage versus immunity
Innovative method to mobilize community for outbreak
Literacy of the population
Outbreak response
Past immunization records not available
poor microplanning
reliable record keeping
security
Timing of outbreak response, selection of target population

Table 8f. Main implementation challenges related to **immunization strategies and outbreak response** to achieve elimination goals (Western Pacific Region).

Challenge #1
Accuracy of data of vaccination coverage
difficulties in access to eligible children
lack of coordination between surveillance and response
poor cold chain in remote areas
Reaching migrant children
Reaching migrant/mobile population
Worry of healthcare workers on high wastage rates especially for MCV affect the coverage
Challenge #2
Integrity of cold chain and proper usage of vaccines
Need for demand creation especially for MCV2
nosocomial infection due to sub-optimal infection control practices
poor implementation of incident command structure to coordinate rapid response and mobilize resources
Strengthening school vaccination record checks
uncertain local communities' commitment
Verifying coverage accuracy
Challenge #3
Eliminating vaccine stock-outs
Ensuring affordable vaccine supply
Laboratory capacity during outbreak (prioritization of cases for testing)
local expense including that for logistics
Stock out of vaccines and related supplies
weak 2nd year of life platform

Table 8g. Main implementation challenges related to **immunization strategies and outbreak response** to achieve elimination goals (Global Level).

Challenge #1
Best strategies to reach the hard to reach
delivery of vaccines depends on links with broader health sector planning and priorities
Delivery of vaccines to marginalized populations
hard to reach and mobile populations
Implementation
Improving birth registration and immunization information systems to track timeliness of vaccine administration, coverage estimates, and defaulter tracking
inadequate monitoring and accountability for performance of national programs
Increase age window to include older children
indicators to guide needed extent of ORIs (by age and geographically)
integration of measles with other preventive services
most cost-effective ways to strengthen ongoing ("routine") services
Vaccine hesitancy
What strategies are most efficient and cost-effective for achieving routine coverage of $\geq 95\%$
Challenge #2
Adequate use of outbreak data for programmatic change
Best approach to controlling outbreaks in various setting
Costs and cost-effectiveness of tailored outreach strategies to vaccinate hard-to-reach/chronically missed children
Finances
guidance to tailor outbreak response to epidemiologic/programmatic situation
insufficient resources for regional/global coordination for outbreak response
Perceived low cost-effectiveness of outbreak response in elimination settings
quality improvement techniques to raise offering and uptake of vaccines
quality of SIA campaigns
Respond to outbreaks more rapidly ensuring financial preparedness
Should national preventive SIAs be advanced in the face of an outbreak?
sustainability, long term planning and resource allocation often at odds with measles short term goals
Challenge #3
competing priorities with other Gavi initiatives
Demand generation, especially for 2nd year of life platform
insufficient recognition of prevention as preferred to outbreak response at the national level in some countries
Is high coverage or speed of response more important in outbreak response?
Poor coverage data
Public awareness
second year vaccination for children

Table 9a. Main implementation challenges related to **vaccine demand and communications** to achieve elimination goals (African Region).

Challenge #1
Availability of vaccine
better use of social media for social mobilization
characterize reasons for vaccine hesitancy in different WHO regions
combatting refusals, rejections and rumors
Communities involvement
Community engagement (I'd put this on previous page)
community mobilization
community involvement
Cost effective communication strategies to reach HTR populations (cultural, nomadic populations etc.)
creating demand for MCV2
Cultural barriers
Effect of IPC
Health workers too busy with activities communication messages not given adequately
how serious is CRS in developing countries
how to ensure the health workers are giving the necessary information to the care taker
Implementing the lessons learned from research and previous initiatives to increase public awareness and demand for vaccination services, e.g., adjusting clinic hours to accommodate working mothers, etc.
Improve community demand for and adherence to vaccination
Inadequate advocacy and social mobilisation.
Inadequate financing/demand creation for routine immunisation
interpersonal communication
Is low vaccine demand the problem or is it lack of service delivery
Knowledge on the importance of measles 1st & 2nd dose
lack of demand for second year platform
Lack of education and communication during immunization sessions, including lack of demonstration materials
lack of information among caregivers
Lack of population awareness of vaccines and schedules
les principales raisons de non vaccination des cibles [the main reasons for non-vaccination of targets]
Low value for immunization
More evaluations of house to house social mobilization
Pooled opinions of the community
poor communication strategies
Poor community participation in coordinating, planning, implementation, monitoring and social mobilization for immunization program
Sustaining communication for immunization beyond SIAs
uncertainty about the best communications methods
Understanding the community attitudes and perceptions
Vaccine hesitancy in developed countries
vaccine rejection among some communities due to rumors
Weak social mobilization activities
What are effective ways to create demand
What are suggested methods to increase coverage for the second year of life (2YL) platform and create 2YL vaccine demand?
What are the main reasons for high dropout rates between DPT1 and MCV1
Challenge #2
Acceptability of vaccination programme amidst AEFIs
Alternate means of communication to care takers not explored
defaulter tracking
How to deal with vaccine resistance especially when it comes from health professionals
how to make the health workers respect full and caring
How to reach out to vaccine hesitant groups more effectively and sustain the demand

Identifying effective mechanisms to ensure that the date, time and venue of outreach sessions is provided to communities in a timely and accurate manner, and ensuring that cancellation of sessions, especially cancelled at short notice or without giving notice to communities, is minimized.

Ignorance on the value of immunization

Inadequate knowledge of some caretakers on immunization schedule.

Increased political will in the context of other high visibility programs (HIV, malaria, maternal mortality etc.)

insufficient vaccine demand

Involvement of community in planning of services

Is lack of information about vaccination responsible for low coverage

lack of demand for RI and good coverage

Lack of public private partnership (vaccines being sold in private clinics)

lack of recent studies on community KAP regarding measles and measles vaccination

les canaux les plus appropriés pour atteindre les populations [the most appropriate channels to reach populations]

level of literacy

Low use of different communication tools by health personnel

Misperception

more evaluations, including economic evaluations, of SMS reminder messaging to improve routine coverage

most effective communication strategy to increase and sustain measles vaccination

negative social media on immunization

poor attitude of health staff towards caregivers

poor community involvement in service planning

Regular and consistent clinic attendance

uncertainly about the value added of different communications strategies

Use of innovative approaches

using community volunteers for demand creation and communication

using technologies such as mhealth and sticker reminders

Vaccination card retention

Weak information, education and communication on routine immunization calendar

What are the best indicators for community involvement and political commitment?

What is the role of modern technology such as cell phone sms to caregivers in increasing coverage and reducing dropout rate

Challenge #3

Advocate effectively that all HCWs are fully vaccinated against VPDs as a condition of their employment in all countries.

Appropriate motivation mechanisms

attitude of health workers

Awareness of vaccine AEFI

Best ways to maximum the benefits and minimize the potential risks posed by social media in SIA

comment obtenir l'adhésion des population lors de AVS [how to obtain the support of the population during AVS]

community ownership of the services

Evaluating advocacy and communication efforts

few severe AEFI not due to vaccine often wrongly communicated associated with vaccine

Gap in knowledge

geographic inaccessibility

health workers not giving information to mothers on measles and rubella

How can communication be better used to drive higher MCV coverage

Inability of health staff to develop novel strategies for reaching the unreached.

Ineffective communication

keeping measles in the public agenda in low incidence settings

lack of HCW knowledge about missed opportunities

Lack of vaccination services everyday (vaccination services should be everyday including the weekend and people should be communicated for any change

more evaluations, including economic evaluations, of SMS alert messaging to improve SIA coverage

Religious beliefs

strategies for community engagement

Weak capacity of communities in passive surveillance of cases

What is the role of civil societies in vaccine advocacy and creation of demand

Table 9b. Main implementation challenges related to **vaccine demand and communications** to achieve elimination goals (Region of the Americas).

Challenge #1
Anti-vaccine activists
effective communication with parents about risks and benefits of measles vaccine
effective communication with the public
Finance
How to overcome vaccine hesitancy
Increase awareness on measles and rubella vaccination in the community
KAB of public re: vaccination
Manutenção de Campanha de Seguimento. [Follow-up campaign maintenance.]
myths surrounding MMR vaccination and how to address them
Public support of elimination goals
Vaccine hesitancy
Vaccine hesitancy/vaccine confidence
vaccine importance
Challenge #2
achieving policies and laws promoting vaccination
Adequate infrastructure
adverse effects
Developing vaccine check platforms in older age groups such as at school entry
health care workers technical capacity for risk communication
How can communicate the benefits of measles and rubella vaccination in elimination setting?
Implantação de Monitoramento Rápido de Cobertura como rotina. [Deployment of Rapid Coverage Monitoring as routine.]
Promotion and educational campaign to maintain vaccine uptake
Risk communication
Challenge #3
addressing adverse events proactively
How can we increase demand for MMR2 vaccination?
social behavior

Table 9c. Main implementation challenges related to **vaccine demand and communications** to achieve elimination goals (Eastern Mediterranean Region).

Challenge #1
content analysis if vaccine rumors
hard-to-reach populations
High political commitment
lack of funds
Refusal of parents to give children supplemental dose of MCV during SIA
Vaccine availability
Challenge #2
Cooperative media
Doubts about vaccine safety
innovative means of communication on vaccinations
private sector
private sector sharing
Training of vaccinator about cold chain, proper vaccine administration
Challenge #3
communication for missed opportunities
Effective community health workers
Lack of awareness of risk/benefit of disease/vaccine
outbreak response
Rumors

Table 9d. Main implementation challenges related to **vaccine demand and communications** to achieve elimination goals (European Region).

Challenge #1
Attitudes and vaccination and recall practices of health care providers
Bad intersectorial work
Better communication with parents for better attitudes and higher vaccine coverage of children
Education of the population
Ensure that in low, middle income countries would not be any shortage of the vaccine
Equitable immunization programme inclusive of Roma
Honest and open interaction between health care providers and general population
impact of the knowledge of the diseases on the decision to accept or not the vaccine
Improving positive adherence towards MCV-1
Inaccurate denominator
Information campaign to increase uptake MMR vaccination
Lack of trust on vaccine safety evidence
mandatory vaccination
Overcoming vaccine hesitancy
Reducing misconceptions regarding measles and rubella vaccinations
rejection of vaccination of some groups of people
Research on what is the real knowledge support of governmental structures (e.g. MoHs) toward MR elimination
Targeted and adapted communication with hard-to-reach population groups
to ensure the quantity of vaccine with WHO prequalification, in necessary dose
To improve confidence on vaccine safety and efficiency. To fight anti-vaccine movements.
Vaccine demand issues are overly emphasized
vaccine security information
Challenge #2
Appropriate supply of MMR vaccine
Government officials are too nervous about the public response to vaccine requirements
Health care professionals should recommend possibility of MMR vaccine for unvaccinated, incompletely vaccinated or unaware of their vaccination status patients after reviewing their medical history
Implementation of strategies to reach every person
improving legislative base
Improving positive attitude towards MCV-1
Increasing the confidence for measles and rubella vaccinations
Low awareness of people about benefits of immunization
Motivation of medical staff
promote the benefits of vaccination
Pro-vaccine health care professionals
Research on reasons for vaccination rejection, in general and MR specific
Strategies to increase demand within the population
To improve vaccine acceptance on sanitary workers.
vaccine hesitancy consequences
Vaccine hesitancy, overall misconceptions and attitudinal barriers among population (including HCP)
What are the relevant messages to increase vaccine demand
Work on better communication with vaccination hesitant groups
Challenge #3
autism and MMR vaccine tale
Be present in social media with correct risk-benefit communication
Improve the availability of high quality information for health professionals and for the public.
Improving region-coordinated SIAs
Involve different actors in the awareness of MMR vaccination campaigns
Involvement of medical staff in delivery messages
Research on public trust in governmental and public health services messages
to announce the population about the importance of vaccine
To reach high risk populations (Roma, refugees, travelers...)

Vx demand and comms needs assessing, and then move on!

What are effective strategies to enable health care workers to obtain up-to-date information about vaccination recommendations and MR epidemiology

Table 9e. Main implementation challenges related to **vaccine demand and communications** to achieve elimination goals (South-East Asia Region).

Challenge #1
Attitudes and perceptions towards immunization
awareness
communication/advocacy tools for health workers and community
Community and system barrier for vaccine
Cost
identify knowledge gaps & sustain demand
identifying effective communication strategy through research
improving advocacy for elimination
Low literacy rate
only one WHO prequalified manufacturer thus need for Advance Market Commitment
Uninterrupted supply of vaccine, syringes
vaccine refusals in some countries / Muslim communities - gradually increasing issue
Challenge #2
act on vaccine hesitancy
attitude
Culturally sensitive communication strategy
involvement of local community, ownership and priority
Lack of community participation
Measles seen as old disease and does not warrant immediate treatment at health facility or by health provider
Proper documentation
Shelf life of vaccines
strengthen distribution system
vaccine confidence
Challenge #3
analysis of data at local level and response immediately
Availability of electronic communication systems
increasing demand for routine vaccination
Innovative communication strategy for vaccine
Lack of information and/or confidence gaps for MR vaccination
reducing wastage rate versus coverage
security

Table 9f. Main implementation challenges related to **vaccine demand and communications** to achieve elimination goals (Western Pacific Region).

Challenge #1
Competing messaging on social media with anti-vaccine disinformation
Cost of vaccine
Delivery of accurate knowledge to the communities
Demand creation needs especially for MCV2
dialogue between donor agency like UNICEF and receiving people, e.g., local government, village chiefs, etc.
Methods for tailoring vaccine delivery
Vaccine safety and risk communication
Challenge #2
communication on vaccine side effects and compensation system
Explaining why measles is an important disease
Involving community in planning immunization services
Knowledge of proper delivery, storage, and use of vaccines in health care workers and delivery service workers
Understanding prevailing community perceptions and influencing same
Challenge #3
Ensuring health care worker vaccination
Maintenance of high vaccination coverage in countries in elimination setting
media's attitudes

Table 9g. Main implementation challenges related to **vaccine demand and communications** to achieve elimination goals (Global Level).

Challenge #1
Addressing anti-vaccine movement
Community engagement
competing messages with other initiatives
Complacency
effective means to dispel hesitancy/opposition
health provider prioritizing need for measles and rubella vaccination
high coverage leads to low concern about MR disease
How to counteract the anti-vaccine sentiment on the internet
lack of awareness of rubella and CRS
Low vaccine confidence
Perceptions of risk after 12 months
population awareness
underfunded communications and demand generation activities
Challenge #2
Anti-vaccination messages not addressed
Appropriate training of HCW, including communication skills
concern on safety of vaccine
effective communication about adverse events
Ensure high enough vaccine production
financial advantages
health provider training to overcome vaccine hesitancy with parents
Hesitancy
How to maintain faith in vaccines when disease risk declines
political and religious sensitivity
Unaware of importance of certain vaccines (e.g., rubella)
weak M&E frameworks for demand and comms effectiveness
with the exception of AFR, lack of awareness in public regarding measles
Challenge #3
Concern over issues that have been pervasive in the literature (e.g., paradoxical effect)
dispelling tale of adverse events
How to manage adverse events to minimize their negative impact
Identification of cultural barriers and factors contributing to hesitancy
poor forecasting of vaccine needs
Quality of health care services at facilities
Social determinants of health

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