Public Health Ontario Santé publique Ontario

To view an archived recording of this presentation please click the following link:

https://youtu.be/7SV73V GRBM

Please scroll down this file to view a copy of the slides from the session.

Disclaimer

This document was created by its author and/or external organization. It has been published on the Public Health Ontario (PHO) website for public use as outlined in our Website Terms of Use. PHO is not the owner of this content. Any application or use of the information in this document is the responsibility of the user. PHO assumes no liability resulting from any such application or use.



Changing Public Health Policy: Congenital Rubella Syndrome (CRS) Prevention and the "Paradoxical Effect"

Dr. Natasha S. Crowcroft, Senior Technical Adviser Measles and Rubella, World Health Organization Inaugural Director, Centre for Vaccine Preventable Diseases and Adjunct Professor DLSPH, University of Toronto





Disclosure: I have no potential conflicts of interests to disclose.



Learning Objectives

- Describe inequity in countries' access to rubella vaccine and the implications for the global burden of congenital rubella syndrome and rubella elimination
- Define the "paradoxical effect" as it applies to immunization coverage
- Outline the key elements needed to change global immunization policy
- Apply the global case study to the elements needed to strengthen local public health policy development





Questions for you







- 1. What is the public health policy problem?
- 2. What did it take to change public health policy?
- What was the outcome and lessons learned? 3.







What is the public health policy problem?

Rubella

Rubella virus: an enveloped, positive-stranded RNA virus, transmitted via direct or droplet contact from nasopharyngeal secretions. Humans are the only natural hosts.

Rubella is typically a **mild**, maculopapular rash along with lymphadenopathy, and a slight fever. About 25% to 50% of infections are asymptomatic.

Rubella during pregnancy can result in:

- Miscarriage
- Fetal death/stillbirth
- Severe birth defects Congenital Rubella Syndrome







What is Congenital Rubella Syndrome?

Canadian National case definitions for confirmed and probable congenital rubella syndrome and for congenital rubella infection

Table 1. Congenital Rubella Syndrome: Clinically Compatible Manifestations

Column A	Column B
 Cataracts or congenital glaucoma (either one or both count as one) Congenital heart defect Sensorineural hearing loss Pigmentary retinopathy 	 Purpura Hepatosplenomeg Microcephaly Micro ophthalmia Mental retardation Meningoencephali Radiolucent bone of Developmental or labetes and progother conditions point



https://www.canada.ca/en/public-health/services/diseases/rubella/information-health-professionalsrubella/national-case-definition-congenital-rubella-syndrome.html

aly

itis disease late onset conditions such as ressive panencephalitis and any ossibly caused by rubella virus

Risk of Congenital Rubella Syndrome (CRS)

TABLE III-RUBELLA DEFECTS FOUND AT FOLLOW-UP IN INFANTS	E
INFECTED AT SUCCESSIVE STAGES OF PREGNANCY	1

		Seropositi	ve infants		Overall
Stage of pregnancy (wk)	No. followed up	Heart and other defect	Deafness alone	% with defect	risk* of rubella defect (%)
<11	9	5	4	100	90
11-12	4	0	2	50	33
13-14	12	0	2	17	11
15-16	14	0	7	50	24
17-18	10	0	0		
>18	53	0	0		
Total	102	5	15	20	

*Estimated from congenital-infection rate following symptomatic rubella at different stages of pregnancy (table II).

Overall risk = % seropositive with defects $\times \%$ infants infected.



Miller E, Cradock-Watson JE, Pollock TM. Consequences of confirmed maternal rubella at successive stages of pregnancy. Lancet. 1982 Oct 9;2(8302):781-4. doi: 10.1016/s0140-6736(82)92677-0

Between January, 1976, and September, 1978, all pregnant women who had rubella confirmed by a **Public Health Laboratory Service** laboratory in England and Wales were followed up prospectively.

ubella defects occurred in **all infants nfected before the 11 th week** (principally ongenital heart disease and deafness) nd in 35% of those infected at 13-16 veeks (deafness alone).

No defects attributable to rubella were found in 63 children infected after 16 weeks.

Lifelong Disabilities of Congenital Rubella Syndrome

1966



<u>At ~5 years of age:</u>

- Severe developmental delay
- Cataract ullet
- Deafness ullet





2005







Photographs courtesy of Dr. Louis Cooper

1970



Relevance to Canada?

Rubella and CRS are eliminated in Canada

Global progress on rubella elimination reduces the risk to **Canadians**

Canada is investing in measles and rubella elimination. The return on investment is maximized when these diseases are eliminated **everywhere**



Source: Medu OA, Mahajan P, Hennink M, Stang L, Anderson M, Tan B, Oyenubi A, Plamondon M, Salvadori MI, Franklin K, Primeau C, Hiebert J, Minion J, Diener T. Congenital rubella syndrome, a case series. Can Commun Dis Rep 2024;50(7/8):274-81. https://doi.org/10.14745/ccdr.v50i78a05







To date in 2024, 82 cases of measles and 1 case of congenital rubella syndrome / infection have been reported, along with 1 measles death.

Source: Measles & Rubella Weekly Monitoring Report - Week 41: October 6 to October 12, 2024 https://www.canada.ca/en/public-health/services/publications/diseasesconditions/measles-rubella-surveillance/2024/week-41.html



Laboratory, Regina, SK

Rubella Containing Vaccine (RCV)

I dose is 95% effective Confers lifelong immunity

Rubella RA 27/3 is the most used vaccine strain

RCV is given in combination with measles containing vaccines







HUMANLY POSSIBLE

Ensure you and your family are fully vaccinated against various diseases.

Contact your healthcare provider today!

UNIZATION FOR ALL IMMUNIZATION FOR ALL IMMUNIZATION FOR ALL IMMUNIZATION FOR



https://www.who.int/southeastasia/news/events/50th-anniversaryof-the-expanded-programme-on-immunization-%28epi%29/posters

WHO recommendations on measles vaccine 80% coverage threshold for Rubella Containing Vaccine (RCV) introduction

2000: Countries can introduce RCV if:

- They can achieve routine first dose measles-containing vaccine (MCV1) coverage level of ≥80%
- **2010:** Countries should introduce RCV if:
 - They can achieve coverage level of 280% through either routine MCV1 or in follow-up campaigns, AND
 - They conduct a wide age-range campaign (1-14 years) prior to introduction
- **2020:** Updated Rubella Position Paper
 - 2010 recommendations were maintained









Campaign definitions for Supplementary Immunization Activities (SIAs)

"Follow-up" campaigns are designed to reach children born since the previous campaign to fill immunity gaps due to suboptimal routine immunization coverage. Usually for children <5 years old

A "Catch-up" campaign refers to a single wide age-range immunization campaign that is designed to reach older children who would otherwise not be vaccinated through the routine schedule. Usually up to 15 years but can be wider

Different from **individual** "catch up immunization" where children who are or were age-eligible for vaccination are given doses they missed.





What was the 80% threshold designed to prevent?

Infectious diseases can have **different effects at different ages**

- E.g. polio, hepatitis A, more severe in adults; pertussis, respiratory syncytial virus, more severe in infants
- The average age at infection can change for various reasons
 - Environmental, e.g. improved hygiene (polio, hepatitis A)
 - Demographic change (smaller families with larger gaps between childbirth)
 - Sudden changes in populations (refugees)
 - immunization programs, if they reduce but don't stop transmission

Increased average age of infection means more susceptible people in older age groups, when outcomes can be more severe





The paradoxical effect of RCV on CRS

- A "paradoxical effect" for rubella occurs when low-to-intermediate RCV coverage leads to a rebound in CRS burden that exceeds no-vaccination levels.
 - Effect has support both theoretically and empirically







Net Harm Worst-case scenario has results in short-term benefit but longterm harm

Time

Can low rubella vaccination coverage cause the paradoxical effect?

Greece and Costa Rica both introduced rubella vaccine in 1970s with: 1. No catch-up campaign 2. many years of very low coverage (<50%) 3. no targeted efforts to reach susceptible age groups in the 20 years between 1970s and 1990s.





(1) Panagiotopoulos et al BMJ 1999;319:1462 https://www.bmj.com/content/319/7223/1462.long (2) Morice, A., Ulloa-Gutierrez, R., & Ávila-Agüero, M. L. (2009). Congenital rubella syndrome: progress and future challenges. Expert Review of Vaccines, 8(3), 323–331. https://doi.org/10.1586/14760584.8.3.323

The problem: 80% coverage threshold is a barrier to Rubella Containing Vaccine (RCV) introduction, causing ongoing inequity

~32,000 children born annually by 2019 with Congenital Rubella Syndrome (CRS)¹ Most infants with CRS are born in countries with no RCV 98% infants with CRS are born in low income or low middle income countries²



Percentage of countries with RCV in routine immunization schedule by World Bank income group 2000-22

Sources:

1. Vynnycky E, et al. Estimates of the global burden of Congenital Rubella Syndrome, 1996-2019. Int J Infect Dis. 2023 Dec;137:149-156

2. Ou AC et al. Progress Toward Rubella and Congenital Rubella Syndrome Elimination — Worldwide, 2012–2022. MMWR Morb Mortal Wkly Rep 2024;73:162-167

Equity and rubella elimination in WHO regions

WHO African region: majority of infants with CRS, most in countries without rubella vaccine; no countries have eliminated rubella

WHO Eastern Mediterranean region: 4/21 countries have eliminated rubella



Map: Nineteen countries yet to introduce rubella vaccine



Source: Frey, K. Congenital Rubella Syndrome Does Not Increase with Introduction of Rubella-Containing Vaccine. *Vaccines* **2024**, *12*, 811. https://doi.org/10.3390/vaccines12070811

In **the rest of the world**, rubella was verified as eliminated in 92% countries by the end of 2023 including the whole of the Americas

Pan American Health Organization	World Health Organization REGIONAL OFFICE FOR THE Americas
INTERNATIONAL EXP	ERT COMMITTEE (IEC)
TO DOCUMENT AND VER	IFY THE ELIMINATION OF
MEASLES, RUBELLA AND CON	GENITAL RUBELLA SYNDROME
Based on the evidence prov National Commissions an epidemiological situation, the been eliminated in the Washington, D.C. 27 September 2016	rided by the Measles-Rubella ad the review of the current IEC concludes that measles has Region of the Americas.
Muschierthalle Dr. Merceline Dahl-Regis Chair, IEC	900000 Dr. Natasha Crowcroft
Jow Juan Autos Dr. José Ignacio Santos	Dr. Lotts Cooper
Ju Cumb. M I. José Cassio de Moraes	Dr. Isabel Pachon

Status of Rubella Containing Vaccine (RCV) introduction

Globally, 19 countries yet to introduce RCV as of 2024

Country	Meets criterion	Implementation planned	• 60
Afghanistan	No	No	• 30
Central African Republic	Νο	No	• 10
Chad	Νο	No	th
Djibouti	Νο	No	•
Ethiopia	Pending	No	
Equatorial Guinea	Νο	No	•
Gabon	Νο	No	
Guinea	Νο	No	
Liberia	Pending	No	•
Niger	Pending	No	
Madagascar	Νο	No	
Somalia	Νο	No	
South Sudan	No	No	*Imnle







- countries planning implementation*
- countries' eligibility is **pending**
- countries **do not reach the 80%** reshold:
- Measles containing vaccination coverage (first dose) 41-76%
- All rely on measles follow-up campaigns to prevent outbreaks
- All would benefit from a wide age-range measles-rubella (MR) vaccine introduction campaign for **measles** prevention
- Implementation ongoing in 2024 in Mali, South Africa and Sudan. Planned in Guinea Bissau 2024, Nigeria and DRC 2025



What did it take to change global public health policy?

Changing policy requires open minds, the willingness to think differently about a problem, and a burning platform

Open Access Article

Congenital Rubella Syndrome Does Not Increase with Introduction of **Rubella-Containing Vaccine**

by Kurt Frey ⊠ ^{[0}

Institute for Disease Modeling, Bill and Melinda Gates Foundation, Seattle, WA 98109, USA





Frey, K. Congenital Rubella Syndrome Does Not Increase with Introduction of Rubella-Containing Vaccine. *Vaccines* **2024**, *12*, 811. https://doi.org/10.3390/vaccines12070811<u>https://www.mdpi.com/2076-393X/12/7/811</u>

Figure 4. Average simulation outcomes incorporating a changing population structure. (A) Mean annual incidence of rubella virus infections per 100 k total population as a function of time following RCV introduction through routine immunization only. (B) Mean annual burden of rubella virus infection per 1 k births.

Global context for immunization policy

- The World Health Organization (WHO) is the global health policy making authority
- Technical work is reviewed by Immunization and Vaccines Research Advisory Committee (IVIR-AC)
 - translates modeling to support evidence informed decision making within immunization programs
- WHO's Strategic Advisory Group of Experts (SAGE) advises WHO on overall global policies and strategies



The Measles & Rubella Partnership - Rubella Task Team

The Measles & Rubella Partnership (M&RP) supports implementation of the global Measles Rubella Strategic Framework through a global partnership

The M&RP Rubella Task Team - experts from all partner organizations and modelers from the Vaccine Impact Modeling Consortium

Objectives to:

- Reduce current and projected future 1. increases in CRS burden
- Avoid future paradoxical increase in CRS 2.
- Enable rubella elimination 3
- Align with Immunization Agenda 2030 goals 4. to accelerate Rubella Containing Vaccine (RCV) introduction and other programmatic goals and objectives









- **Goal:** to determine how to reduce Congenital Rubella Syndrome (CRS) burden and **inequity**



Push back during the process – important to listen

"This is too high risk – if you get it wrong it could undermine all vaccination"

Imperative to make a very robust evidence-based case for the policy change

"I don't believe in modeling"

- Include different types of evidence to support the modeling results.
- "I don't believe these countries can implement campaigns **this won't work**"
 - Provide evidence and narrative from credible sources that these countries can do it
- "M&RP is an advocacy group what you are saying is not credible"
 - Be clear about the role of M&RP, be careful with language, include field colleagues

"What is the question for SAGE? Is this about policy or implementation?"

- The question is only whether to drop the 80% threshold for rubella vaccine introduction.
- No change to other policy recommendations wide age-range campaigns at introduction and regular follow up campaigns until countries reach at least 90% routine coverage.
- Changed the title of the session from "Rubella" to "CRS Prevention" to focus on equity/values



Expect lots of process in addition to scientific review

Proposal presented at multiple internal meetings to get feedback and define the pathway

Final sequence:

- Immunization and Vaccines Related Implementation Research Advisory **Committee** (IVIR-AC) ad-hoc review of modeling methodology **completed** 28th June – 1st July 2024
- 2. SAGE Pre-meeting 2nd September 2024 to present the modeling to SAGE members including work presented to IVIR-AC and subsequent scenario modeling
- **CRS prevention session** at SAGE 25th September 2024 3.



Step 1. Immunization and Vaccines Related Implementation Research Advisory Committee (IVIR-AC) : Review of modeling methodology

"Across Nigeria, the basic reproduction number ranged from 2.6 to 6.2. Consequently, the conditions for safe vaccination varied across states with low-risk areas requiring coverage levels well below 80 %."







В



Taishi Nakase, Tenley Brownwright, Oyeladun Okunromade, et al, The impact of subnational heterogeneities in demography and epidemiology on the introduction of rubella vaccination programs in Nigeria, Vaccine, Volume 42, Issue 20, 2024, 125982, ISSN 0264-410X https://doi.org/10.1016/j.vaccine.2024.05.030

Immunization and Vaccines Related Implementation Research Advisory Committee (IVIR-AC) - Conclusions

After reviewing the presented methods and evidence, IVIR-AC:

- finds that the methodology used to address these questions **is appropriate**;
- welcomes the additional projection modeling analyses and recommends supplementary scenarios to complement those planned; and
- emphasizes the need for transparent, nuanced, and contextualized communication of methodologic assumptions and scenario results.

Step 2: Modelling presented to SAGE with Scenario results



Lambach P, Silal S, Sbarra AN, Crowcroft NS, Frey K, Ferrari M, Vynnycky E, Metcalf CJE, Winter AK, Zimmerman L, Koh M, Sheel M, Kim SY, Munywoki PK, Portnoy A, Aggarwal R, Farooqui HH, Flasche S, Hogan AB, Leung K, Moss WJ, Wang XY. Report from the World Health Organization's immunization and vaccines-related implementation research advisory committee (IVIR-AC) ad hoc meeting, 28 June - 1 July 2024. Vaccine. 2024 Sep 13;42(26):126307. doi: 10.1016/j.vaccine.2024.126307.

Step 3. Presentation to SAGE: Observational data on Rubella **Elimination - Member States Verified as Eliminated by Year**

Progress with verification of measles and rubella elimination – despite some setbacks due to measles outbreaks.

99 Member States verified rubella – 51%

83 Member States verified measles – 43%





Verification Committee (NVC) through data collection as of 31 March 2024.

51% Member States have verified and sustained rubella elimination : Rubella incidence by RCV introduction status, 2023

Elimination status	Coverage category	Average incidence per million	Weighted average incidence per million	Median incidence
Not eliminated, No RCV in program	0%	55.6	2.02	8.7
Not eliminated, RCV introduced	Less than 80%	7.3	0.20	1.4
into program	80% and above	2.6	0.03	1.1
Rubella verified	Less than 80%	0.1	0.00	0.0
as eliminated	80% and above	0.1	0.00	0.0







Empirical data from AFRO and EMRO supports RCV introduction

African Region: Big appetite for rubella vaccine introduction across the Region

- Significant and sustained reduction in rubella incidence post-introduction
- Some documented spikes in rubella incidence (mainly among children < 10 yrs) related to declining routine immunisation coverage, delays in periodic campaigns, poor quality campaigns
- Ample country experience in conducting wide age range SIAs

Eastern Mediterranean Region: Afghanistan, Djibouti and Somalia are interested to introduce RCV

- Pakistan's long-term success depends on introduction in Afghanistan since there is much cross-border • movement between the two countries
- Countries in the region have extensive experience conducting SIAs •
- Despite the grave situation in Somalia, Sudan, and Yemen, all three countries eliminated polio, and they can eliminate rubella with full introduction and ongoing support





With thanks to Dr. Balcha Masresha and Dr. Muhammad Farid

	SCE	NARIO									C	Countr	Ŋ		
	CU	FU													
RI	Intro	campaigns	SOM	CAF	GNQ	NGA	TCD	GIN	AFG	COD	DìI	ETH	GAB	GNB	LB
	90%	90%													
	80%	90%													
	70%	90%													
	60%	90%													
	90%	60%													
	80%	60%													
0	70%	60%													
NIC	60%	60%													
VUE	90%	90%													
>	80%	80%													
	70%	70%													
	60%	60%													
	90%		20/30	20	17	18	18								
	80%		20/28	14	17	18	19								
	70%		19/27	18	17	18	19								
	60%		18/26	18	17	18	18								
			16/19	16	16	17	16	26							

Without sustained follow-up campaigns, some countries may see an **increase in annual CRS incidence above the no-vaccine baseline** after 14 or more years following introduction, even with a high-quality catch-up campaign (CU). But 14 countries would see **no increase in CRS** even without follow-up (FU) campaigns







Without sustained follow-up campaigns, some countries may see an **increase in annual CRS incidence above the no-vaccine baseline** after 14 or more years following introduction, even with a high-quality catch-up campaign (CU). But 14 countries would see **no increase in CRS** even without follow-up (FU) campaigns





Without sustained follow-up campaigns, some countries may see an **increase in annual CRS incidence above the no-vaccine baseline** after 14 or more years following introduction, even with a high-quality catch-up campaign (CU). But 14 countries would see **no increase in CRS** even without follow-up (FU) campaigns





Without sustained follow-up campaigns, some countries may see an **increase in annual CRS incidence above the no-vaccine baseline** after 14 or more years following introduction, even with a high-quality catch-up campaign (CU). But 14 countries would see **no increase in CRS** even without follow-up (FU) campaigns



	SCE	NARIO									C	Countr	тy		
	CU	FU													
RI	Intro	campaigns	SOM	CAF	GNQ	NGA	TCD	GIN	AFG	COD	DìI	ETH	GAB	GNB	LB
	90%	90%													
	80%	90%													
	70%	90%													
	60%	90%													
	90%	60%													
	80%	60%													
0	70%	60%													
NIN	60%	60%													
VUE	90%	90%													
>	80%	80%													
	70%	70%													
	60%	60%		_				_							
	90%		20/30	20	17	18	18								
	80%		20/28	14	17	18	19				ret	000		onari	
	70%		19/27	18	17	18	19			000	ISU	CUSE		FIGH	0
	60%		18/26	18	17	18	18								
			16/19	16	16	17	16	26							

Without sustained follow-up campaigns, some countries may see an **increase in annual CRS incidence above the no-vaccine baseline** after 14 or more years following introduction, even with a high-quality catch-up campaign (CU). But 14 countries would see **no increase in CRS** even without follow-up (FU) campaigns





	SCE	NARIO									C	Countr	Ŋ		
	CU	FU													
RI	Intro	campaigns	SOM	CAF	GNQ	NGA	TCD	GIN	AFG	COD	DìI	ETH	GAB	GNB	LB
	90%	90%													
	80%	90%													
	70%	90%													
	60%	90%													
	90%	60%													
	80%	60%													
0	70%	60%													
NIC	60%	60%													
VUE	90%	90%													
>	80%	80%													
	70%	70%													
	60%	60%													
	90%		20/30	20	17	18	18								
	80%		20/28	14	17	18	19								
	70%		19/27	18	17	18	19								
	60%		18/26	18	17	18	18								
			16/19	16	16	17	16	26							

Without sustained follow-up campaigns, some countries may see an **increase in annual CRS incidence above the no-vaccine baseline** after 14 or more years following introduction, even with a high-quality catch-up campaign (CU). But 14 countries would see **no increase in CRS** even without follow-up (FU) campaigns





Conclusions: Current CRS burden is significant and avoidable

Evidence for the 80% Rubella Containing Vaccine (RCV) introduction threshold has changed since 2000

Accumulating programmatic evidence:

- Rubella incidence has fallen greatly in countries that have introduced RCV 51% of countries in the world have been verified to have eliminated rubella; all have
- sustained elimination
- Catch-up and follow-up campaigns are highly effective at reducing rubella transmission These strategies are feasible even in fragile and humanitarian settings

Evidence from modeling:

- R₀ for rubella in countries yet to introduce RCV is **lower than previous assumptions**, even at sub-national level
- Expected birth rate declines and aging populations will increase CRS rate in the absence of • vaccination
- Routine Immunization (RI) coverage is currently sufficient to prevent paradoxical effect in most countries; RI plus campaigns prevent paradoxical effect in all countries.



•



What was the outcome and lessons learned?

In September 2024 SAGE recommends Universal **Rubella Containing Vaccine (RCV) introduction**

SAGE recommended lifting the requirement that countries attain 80% Measles Containing Vaccine (MCV) coverage in routine or campaigns before RCV introduction.

- SAGE recommended introduction in the 13 countries yet to introduce the vaccine
- SAGE reinforced current WHO policy for RCV introduction with a wide age-range campaign
- SAGE reinforced WHO policy for regular follow-up campaigns in all countries until they reach 90% routine MCV1/MRCV1 immunization coverage.

https://www.who.int/publications/i/item/WHO-WER9527







Lessons learned for changing policy

Look for new evidence all the time, don't take the evidence base for policy for granted.

Have a **clearly defined problem** to solve, a policy question and a defined pathway to change policy. Good process is essential

Good partnerships between academia, programmatic and field experts. Need the right people in the team.

Clarity on who needs to be convinced - test out your thinking, listen, be flexible and creative. Involve those most affected by the change, build a constituency.

Assemble the right kind of evidence. Bring scientific research, observational data and experiential public health wisdom **together** to drive public health policy forward. Use data well.

Values are a guiding star

Remember, if you succeed, you will need to implement the policy







Likely impact of the policy change

Millions of children from 9 months to 15 years will be vaccinated and protected from measles and rubella. They mainly live or will be born in the African continent

- 6 countries in progress : largest are Nigeria (total population 234 million) and Democratic Republic of Congo (110 million)
- 13 countries now able to introduce, some already decided to move ahead Countries will need a lot of support for implementation

Tens of thousands of infants per year will not be born with CRS, and projected future increases in CRS will be prevented

Rubella elimination in the African and Eastern Mediterranean regions is now possible

Measles Rubella wide age range catch campaigns will **prevent many deaths from** measles







With acknowledgement of the M&RP Rubella Task Team and co-presenters at SAGE:

Dr. Balcha Masresha (WHO AFRO), Dr. Muhammad Farid (WHO EMRO), Professor Matt Ferrari (Penn State), Professor Emilia Vynnycky (UK HSE), Professor Amy Winter (UGA), Dr. Kurt Frey (IDM), Laura Zimmerman (US CDC)

All the other members of the Rubella Task Team Gavi: Marguerite Cornu, Arunima Khanduri, Stephen Sosler; BMGF: Kendall Krause, Ex-CDC: Susan Reef CDC: Christine Dubray, James Goodson, Emma Lebo, Gavin Grant, Richard Luce, Jim Alexander, Cynthia Hatcher, Kimberly Dautel, Melissa Dahlke, Robert Perry, Chris Hsu, Mark Papania, Michelle Morales, Pratima Raghunathan; WHO: Patrick O'Connor

Thank you!

80% threshold known to be conservative for several years

	Vaccine: X 9 (2021) 100127		•
	Contents lists available at ScienceDirect		
\$-\$2.14 <u>0</u>	Vaccine: X	Accilie.	3
ELSEVIED	iournal homenage: www.elsevier.com/locate/ivacy		ĸ
ELSEVIER		A REAL PROPERTY OF THE RE	KC
Examination of sc	onarios introducing ruballa vassing in the Domo	cratic	
	enalios incroducing rubena vaccine in the Denio		
Republic of the Co	ongo	Check for updates	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F	ongo rev ^{.b,*,1} . Guillaume Ngoie Mwamba ^c . Kevin A. McCarthy ^b . Nic	cole A. Hoff ^a .	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F Anne W. Rimoin ^a	rey ^{b,*,1} , Guillaume Ngoie Mwamba ^c , Kevin A. McCarthy ^b , Nic	cole A. Hoff ^a ,	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F Anne W. Rimoin ^a ^a Department of Epidemiology, Universe ^b Institute for Disease Modeling, Bill G	rey ^{b,*,1} , Guillaume Ngoie Mwamba ^c , Kevin A. McCarthy ^b , Nic	cole A. Hoff ^a ,	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F Anne W. Rimoin ^a ^a Department of Epidemiology, Universe ^b Institute for Disease Modeling, Bill & ^c VillageReach, Ngaliema, Kinshasa, The	ongo rey ^{b,*,1} , Guillaume Ngoie Mwamba ^c , Kevin A. McCarthy ^b , Nic sity of California, Los Angeles, CA, USA Melinda Gates Foundation, Seattle, WA, USA e Democratic Republic of the Congo	cole A. Hoff ^a ,	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F Anne W. Rimoin ^a ^a Department of Epidemiology, Univers ^b Institute for Disease Modeling, Bill & ^c VillageReach, Ngaliema, Kinshasa, The ARTICLE INFO	A B S T R A C T	cole A. Hoff ^a ,	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F Anne W. Rimoin ^a ^a Department of Epidemiology, Univers ^b Institute for Disease Modeling, Bill & ^c VillageReach, Ngaliema, Kinshasa, The ARTICLE INFO Article history:	A B S T R A C T Background: Rubella vaccine has yet to be introduced into the national	cole A. Hoff ^a ,	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F Anne W. Rimoin ^a ^a Department of Epidemiology, Univers ^b Institute for Disease Modeling, Bill & ^c VillageReach, Ngaliema, Kinshasa, The ARTICLEINFO ARTICLEINFO Article history: Received 9 May 2021 Received in revised form 10 October	A B S T R A C T Background: Rubella vaccine has yet to be introduced into the national Democratic Republic of the Congo (DRC); the current burden of conger unknown and likely to be high. An important consideration prior to	immunization schedule of the nital rubella syndrome (CRS) is introducing rubella containing	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F Anne W. Rimoin ^a ^a Department of Epidemiology, Univers ^b Institute for Disease Modeling, Bill & ^c VillageReach, Ngaliema, Kinshasa, The ARTICLE INFO Article history: Received 9 May 2021 Received in revised form 10 October	A B S T R A C T Background: Rubella vaccine has yet to be introduced into the national Democratic Republic of the Congo (DRC); the current burden of conger unknown and likely to be high. An important consideration prior to	cole A. Hoff ^a ,	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F Anne W. Rimoin ^a ^a Department of Epidemiology, Universe ^b Institute for Disease Modeling, Bill & ^c VillageReach, Ngaliema, Kinshasa, The A R T I C L E I N F O Article history: Received 9 May 2021 Received 9 May 2021 Received in revised form 10 October Accepted 29 October 2021 Available online 12 November 2021	Presentation of the order of the congo Presentation of the co	immunization schedule of the hital rubella syndrome (CRS) is introducing rubella containing coverage and CRS incidence. n. Cumulative infections across	
Republic of the Co Alvan Cheng ^{a,1} , Kurt F Anne W. Rimoin ^a ^a Department of Epidemiology, Univers ^b Institute for Disease Modeling, Bill & ^c VillageReach, Ngaliema, Kinshasa, The A R T I C L E I N F O Article history: Received 9 May 2021 Received in revised form 10 October Accepted 29 October 2021 Available online 12 November 2021 Keywords:	2021 A B S T R A C T 2021 Background: Rubella vaccine has yet to be introduced into the national Democratic Republic of the Congo (DRC); the current burden of conger unknown and likely to be high. An important consideration prior to vaccine (RCV) is the potential inverse relationship between RCV Increasing RCV coverage will also increase in the average age of infection all age groups will decrease, but the number of infections in age groups will decrease, but the number of infections in age groups will decrease.	immunization schedule of the nital rubella syndrome (CRS) is introducing rubella containing coverage and CRS incidence. n. Cumulative infections across vulnerable to CRS may increase.	

Cheng et al: "Continued endemic transmission is only plausible when routine immunization coverage is **less than 40%** and follow-up supplemental immunization activities have poor coverage **for decades**."



Cheng A et al Examination of scenarios introducing rubella vaccine in the Democratic republic of Congo. Vaccine X 9 (2021) <u>https://www.sciencedirect.com/science/article/pii/S2590136221000449?via%3Dihub</u> <u>https://doi.org/10.1016/j.jvacx.2021.100127</u>.

