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Assessment of Vaccine Herd Protection: Lessons learned from vaccine trials Part I

This is the first article of a series of 3 articles on the "Assessment of Vaccine Herd Protection: Lessons learned from vaccine trials". Part I'.

The following series of articles are based on the concepts introduced in the previous WERs Vol.50 No. 36 & 37 and on 'Assessment of Vaccine Herd Protection'

To recap, vaccines provide direct protection to vaccine recipients by activating an immune response against targeted infections. This protection occurs regardless of the level of vaccination of the surrounding population. When vaccines are administered in a community, there will be extension of the vaccine protection beyond the vaccine recipients to unvaccinated persons, as well as greater protection among the vaccinated.[1]

Vaccine population effects can either result from **vaccine herd immunity** or **vaccine herd protection**, which are to be considered as two separate entities, though they are often used interchangeably.[2]

Vaccine herd protection is traditionally inferred from observations of disease trends after inclusion of a vaccine in national immunization schedules. However, instead of waiting for such impact assessments post widescale vaccine deployment, it would be more prudent to conduct earlier stage evaluation of **vaccine herd protection** to assist in forming policy decisions about potential vaccine introduction. Herd protection assessments using the cholera and typhoid vaccine studies have revealed the importance of vaccination as an additional tool of prevention and control, along with the more traditional control measures such as prompt case management and improved access to safe water, sanitation and hygiene. Herd protection augments the impact of cholera and typhoid fever vaccinations and prevents the need to vaccinate the entire population to control transmission. Furthermore, the overwhelming impact of uncontrolled cholera outbreaks and typhoid fever, coupled with the rapid worldwide surge in antimicrobial drug resistance, shows us the importance and use of **vaccine herd protection** against such diseases.[1]

Components of Vaccine Herd Protection

Vaccine herd protection is a vaccine preventive impact in a population above that expected from direct vaccine protection and level of vaccine coverage. Components of **vaccine herd protection** include[1]:

INDIRECT Protection
What is conferred to the unvaccinated in the population through decreased exposure to the pathogen

TOTAL Protection
Enhanced defense of the vaccinated due to their proximity to other vaccinated persons

OVERALL Protection
of the entire population, irrespective of the vaccination status of its individual persons, due to the combination of indirect and total effects.

Vaccine Herd Immunity	Vaccine Herd Protection
Protection of nonvaccinated persons resulting from their exposure and immune response to live vaccine organisms shed by vaccinees in their community. E.g. oral polio vaccine.	This results from a decline in transmission of a pathogen within a community when a sufficient portion of the population has been immunized.
Only applies to live vaccines that induce shedding & does not depend on whether the infection is spread from person to person, or via another route.	Can be induced by live or non-live vaccines but occurs only for infections that are transmitted from person to person (directly or indirectly). ***Cocooning** – strategy of vaccinating those in close contact with immunocompromised persons or infants too young to receive or mount a vaccine response, focusing on especially vulnerable persons.*[3]

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***Direct immunity** – refers to protection mediated through an immune response to the vaccine. However, individuals who are immunologically naïve to the disease of interest and shielded by indirect protection alone, remain FULLY susceptible to the disease, should they be exposed to the pathogen of interest.

Influencing Factors & Implications of Vaccine Herd Protection

Level of **vaccine herd protection** in a community can be ***influenced*** by several factors[1,4]:

- Direct protection against symptomatic and asymptomatic disease conferred to vaccinees;
- Preexisting immunity of the population;
- Vaccine coverage;
- Extent of community mixing and mobility

This leads us to several implications of vaccine herd protection:

- Some vaccines may be cost effective only when impact of herd protection is considered e.g. inactivated oral cholera vaccines.[5]
- Demonstration of herd protection especially for vaccines that confer moderate individual protection, can determine whether the use of such vaccines in populations will be sufficient for disease control. Even if insufficient to achieve disease elimination in such instances, the reduction of infection risk in the population by lesser degree of herd protection may be a worthy public health goal.
- Herd protection can also shield those in whom immunization is not possible such as young children and the immunocompromised.
- When infection prevalence has considerably reduced, **vaccine herd protection** may prevent the emergence and spread of variants of some pathogens.
- On the negative side, **vaccine herd protection** can alter disease epidemiology such as shifting average age of infection to adulthood. This could be significant if clinical outcomes are more severe if occurring at an older age.
- Also, **vaccine herd protection** could exert selection pressure that results in serotype replacements which is an issue that is under observation in pneumococcal immunization programs.[6]

*These are issues that need to be considered when deciding on widescale vaccine deployment.

The "free-rider" paradox – where persons living in a community with high vaccine coverage, who themselves refuse to be vaccinated due to vaccine hesitancy/refusal or antivaccination sentiments, may ironically benefit from herd protection.

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Adapted from the following Sources

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Table 1 : Water Quality Surveillance
Number of microbiological water samples August 2023

District	MOH areas	No: Expected *	No: Received
Colombo	15	90	**0**
Gampaha	15	90	**NR**
Kalutara	12	72	**74**
Kalutara NIHS	2	12	**30**
Kandy	23	138	**27**
Matale	13	78	**0**
Nuwara Eliya	13	78	**1**
Galle	20	120	**103**
Matara	17	102	**122**
Hambantota	12	72	**NR**
Jaffna	12	72	**155**
Kilinochchi	4	24	**4**
Manner	5	30	**0**
Vavuniya	4	24	**23**
Mullatvu	5	30	**33**
Batticaloa	14	84	**0**
Ampara	7	42	**NR**
Trincomalee	11	66	**NR**
Kurunegala	29	174	**NR**
Puttalam	13	78	**0**
Anuradhapura	19	114	**7**
Polonnaruwa	7	42	**38**
Badulla	16	96	**0**
Moneragala	11	66	**10**
Rathnapura	18	108	**NR**
Kegalle	11	66	**28**
Kalmunai	13	78	**6**

* No of samples expected (6 / MOH area / Month)
NR = Return not received

to be continued ...

Table 1: Selected notifiable diseases reported by Medical Officers of Health 09th– 15th Sep 2023 (37th Week)

RDHS	Dengue Fever		Dysentery		Encephalit		Enteric Fever		Food Poi-		Leptospirosis		Typhus		Viral		Human		Chickenpox		Meningitis		Leishmania-		WRCD	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	T*	C**
Colombo	90	11520	1	14	0	11	0	2	1	12	15	259	0	0	0	5	0	0	14	253	1	36	0	6	**40**	**100**
Gampaha	81	11622	0	19	0	14	0	7	0	5	27	459	0	8	0	15	0	0	12	230	3	91	1	37	**8**	**100**
Kalutara	57	4057	0	20	0	2	0	1	5	11	31	685	0	2	2	10	0	1	10	406	2	85	1	2	**63**	**200**
Kandy	125	5992	4	33	0	1	0	10	0	17	9	237	2	49	0	3	0	2	12	218	0	22	0	25	**89**	**100**
Matale	20	1324	2	4	0	3	0	1	13	27	3	126	1	14	1	6	0	0	2	52	2	7	8	251	**28**	**100**
NuwaraEliya	5	232	2	133	0	4	0	3	1	49	3	119	1	61	0	5	0	0	4	141	1	22	1	3	**63**	**100**
Galle	56	2290	0	39	0	13	0	5	3	27	15	756	7	64	0	2	0	1	6	265	1	24	0	3	**38**	**100**
Hambantota	11	1258	0	9	0	3	0	1	0	9	3	249	1	67	0	9	0	0	6	123	1	17	24	496	**32**	**100**
Matara	33	1581	1	22	0	8	0	1	1	18	5	442	0	30	0	5	0	2	8	248	1	17	8	149	**59**	**100**
Jaffna	34	1983	0	83	0	2	0	12	2	30	0	12	0	501	0	5	0	2	1	154	0	14	0	2	**66**	**93**
Kilinochchi	0	86	1	9	0	0	0	1	0	16	0	8	0	7	0	0	0	0	1	17	0	2	0	0	**34**	**100**
Mannar	2	81	0	6	0	0	0	1	0	0	1	35	0	5	1	1	0	0	0	2	0	8	1	1	**51**	**100**
Vavuniya	3	149	1	10	0	1	0	0	8	17	0	30	0	8	1	2	0	0	0	21	0	12	0	10	**18**	**100**
Mullaitivu	1	117	0	13	0	1	0	4	0	12	1	36	0	6	0	1	0	0	0	12	0	2	0	7	**25**	**100**
Batticaloa	10	2140	1	163	0	8	0	5	0	18	3	78	0	1	2	8	0	1	1	80	3	31	0	1	**65**	**100**
Ampara	2	213	0	7	0	1	0	1	1	53	2	114	0	2	0	1	0	0	7	69	1	43	1	7	**10**	**100**
Trincomalee	2	1994	1	22	0	1	0	1	0	65	3	64	0	15	0	3	0	0	4	60	0	28	3	5	**30**	**100**
Kurunegala	38	2589	0	38	0	15	0	1	0	6	1	321	0	16	1	10	0	2	16	440	6	169	12	424	**29**	**100**
Puttalam	8	2877	2	30	0	3	0	1	0	2	3	71	0	8	0	1	0	0	2	92	1	58	0	19	**28**	**100**
Anuradhapur	8	668	1	13	0	1	0	1	0	8	5	242	0	30	0	4	0	2	4	204	0	43	27	479	**30**	**100**
Polonnaruwa	7	523	1	14	1	6	0	1	0	11	5	151	0	6	0	12	0	0	3	73	1	17	16	341	**36**	**100**
Badulla	13	940	1	33	0	5	0	0	0	44	4	282	2	51	2	80	0	0	2	138	1	39	1	35	**67**	**100**
Monaragala	10	608	0	21	0	6	0	0	0	5	4	453	2	36	1	23	0	1	0	61	1	68	2	145	**30**	**100**
Ratnapura	27	1900	1	39	0	15	0	2	2	19	21	978	0	27	0	16	0	2	5	174	1	129	0	140	**37**	**100**
Kegalle	55	2649	0	22	0	2	0	2	0	15	18	567	1	37	0	5	0	0	20	367	2	70	0	34	**33**	**100**
Kalmune	4	1674	0	65	0	10	0	0	0	0	0	48	0	1	0	0	0	0	9	109	0	34	0	0	**50**	**100**
SRILANKA	**702**	**61067**	**20**	**881**	**1**	**136**	**0**	**64**	**37**	**496**	**182**	**6822**	**17**	**1052**	**11**	**232**	**0**	**16**	**149**	**4009**	**29**	**1088**	**106**	**2622**	**42**	**99**

Source: Weekly Returns of Communicable Diseases (esurvillance.epid.gov.lk). T=Timeliness refers to returns received on or before 15th Sep, 2023 Total number of reporting units 358 Number of reporting units data provided for the current week: 358 **C****-Completeness

A = Cases reported during the current week. B = Cumulative cases for the year.

Table 2: Vaccine-Preventable Diseases & AFP

09th– 15th Sep 2023 (37th Week)

Disease	No. of Cases by Province									Number of cases during current week in 2023	Number of cases during same week in 2022	Total number of cases to date in 2023	Total number of cases to date in 2022	Difference between the number of cases to date in 2023 & 2022
	W	C	S	N	E	NW	NC	U	Sab					
AFP*	00	01	02	00	01	00	01	00	00	05	02	71	57	24.5 %
Diphtheria	00	00	00	00	00	00	00	00	00	00	00	00	00	0 %
Mumps	00	00	01	00	00	00	00	02	00	03	00	174	63	176.1 %
Measles	28	04	02	01	01	00	05	00	02	43	01	421	17	2376.4 %
Rubella	01	00	00	00	00	00	00	00	00	01	00	05	00	0 %
CRS**	00	00	00	00	00	00	00	00	00	00	00	02	00	0 %
Tetanus	00	00	00	00	00	00	00	00	00	00	00	06	05	20 %
Neonatal Tetanus	00	00	00	00	00	00	00	00	00	00	00	00	00	0 %
Japanese Encephalitis	00	00	00	00	00	01	01	00	00	00	00	02	01	100 %
Whooping Cough	00	01	00	00	00	00	00	00	00	01	00	07	01	600 %
Tuberculosis	76	54	06	09	07	24	04	02	15	197	54	6574	4790	37.2%

Key to Table 1 & 2

Provinces: **W**: Western, **C**: Central, **S**: Southern, **N**: North, **E**: East, **NC**: North Central, **NW**: North Western, **U**: Uva, **Sab**: Sabaragamuwa.

RDHS Divisions: **CB**: Colombo, **GM**: Gampaha, **KL**: Kalutara, **KD**: Kandy, **ML**: Matale, **NE**: Nuwara Eliya, **GL**: Galle, **HB**: Hambantota, **MT**: Matara, **JF**: Jaffna, **KN**: Killinochchi, **MN**: Mannar, **VA**: Vavuniya, **MU**: Mullaitivu, **BT**: Batticaloa, **AM**: Ampara, **TR**: Trincomalee, **KM**: Kalmunai, **KR**: Kurunegala, **PU**: Puttalam, **AP**: Anuradhapura, **PO**: Polonnaruwa, **BD**: Badulla, **MO**: Moneragala, **RP**: Ratnapura, **KG**: Kegalle.

Data Sources:

Weekly Return of Communicable Diseases: Diphtheria, Measles, Tetanus, Neonatal Tetanus, Whooping Cough, Chickenpox, Meningitis, Mumps., Rubella, CRS,

Special Surveillance: AFP* (Acute Flaccid Paralysis), Japanese Encephalitis

CRS =**Congenital Rubella Syndrome

NA = Not Available

Influenza Surveillance in Sentinel Hospitals - ILI & SARI							
Month	Human				Animal		
	No Total	No Positive	Infl A	Infl B	Pooled samples	Serum Samples	Positives
August							

Source: Medical Research Institute & Veterinary Research Institute

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