WEEKLY EPIDEMIOLOGICAL REPORT

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Assessment of Vaccine Herd Protection Part II

This is the second article of series of two articles regarding 'Assessment of Vaccine Herd Protection Part II'.

On the other hand, **vaccine herd protection** results from the reduction of the intensity of transmission of the targeted infection in a population, owing to the presence of people who are made immune to the infection by vaccination. This reduced intensity of transmission arises from the reduced transmission from exposed vaccinees to their subsequent contacts. Herd protection can be induced by both live vaccines (e.g. measles vaccine) and by non-live vaccines (e.g. whole cell pertussis vaccine). In contrast with vaccine herd immunity, vaccine herd protection occurs only for target infections that are transmitted from person to person, either directly or indirectly.[1]

Reduction in the transmission intensity of the target pathogen in a population can result in protection of non-vaccinated neighbors, termed indirect protection. This is in contrast to the direct protection of a vaccinated person owing only to the vaccine-induced immunity in that person. Further, reduction in transmission intensity can result in improved protection of vaccinees, because of a reduction in exposure to the pathogen and sometimes because of the greater ability of vaccine-induced immunity to protect against a light rather than a heavy challenge. Thus, this enhanced protection of vaccinees attributable to both the direct vaccine protection & the additional protection attributable to reduced transmission is termed as 'total protection.

Herd Immunity Threshold

A common variable that we see in relation to vaccine herd protection is the herd immunity threshold that reflects the proportion of the population that must be immune – because of vaccination or natural immunity – for herd protection to eliminate person-to-person transmission. If this is reached, for example through immunization, then each case leads to a single new case (R = 1) and the infection will become stable within the population.

$$\text{Herd Immunity Threshold (HIT)} = \frac{R0-1}{R0} \quad \text{OR} \quad 1-\frac{1}{R0}$$

If the threshold for herd immunity is surpassed, then R < 1, and the number of cases of infection will decrease. This is an important measure used in infectious disease control, immunization and eradication programmes.

Traditional assessments of vaccine herd protection after license of vaccines

Traditionally, the herd protective effects of vaccines have been studied mainly after licensing and when being used in public health practice, where both *concurrent* (collection of different types of data at the same time) and *nonconcurrent* (collection of data of different individuals at different times) study designs are used.

An example of a concurrent study design is the study of the incidence of measles in non-vaccinated children residing in different regions of Milwaukee, USA, which displayed that the incidence of measles among non-vaccinated children who were concurrently followed up was inversely related to the level of coverage of children given the measles vaccine. This finding is consistent with the concept of vaccine herd protection of non-vaccinated children.[2]

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A more frequent design to assess vaccine herd protection compares secular trends of the incidence of the target disease with secular trends of vaccine coverage of the targeted population. Through this design, an assessment is carried out of whether the secular decrease in disease incidence is more than what could be expected on the basis of level of coverage of the population targeted for vaccination. An example of this type of assessment is the analysis of the decrease in invasive pneumococcal disease attributable to vaccine serotypes in the USA after introduction of a 7-valent pneumococcal protein conjugate vaccine in childhood immunization programmes; which showed a dramatic fall in incidence in targeted age groups that was much higher than could be explained on the basis of vaccine coverage levels and known individual-level protective efficacy of the vaccine; with an extra finding of major decrease in disease in elderly population (a group that was not targeted for vaccination).[3]

New Approaches to Assessment of Vaccine Herd Protection

Often small clinical trials are done prior to vaccine licensing to assess if the vaccine reduces mucosal colonization by the target pathogen among vaccinees, theorizing that preventing colonization by vaccination could translate into vaccine herd protection. This is evidenced through the *Haemophilus influenzae* type b & pneumococcal polysaccharide-protein conjugate vaccines, which provide protection to vaccine recipients against nasopharyngeal colonization with vaccine-targeted organisms, and thus this reduced colonization is theorized to spur the herd protective effects against invasive disease, conferred by these vaccines. A shortcoming of this type of trial is that they are insufficient to confirm if the vaccine confers such protection and further do not allow assessment of relation between extent of vaccine coverage and extent of anticipated vaccine herd protection.[1]

Phase 3 individually randomized vaccine efficacy trials which are required by most national regulatory bodies prior to vaccine licensing, are designed to measure only the direct vaccine protection of the vaccine recipients. This type of randomization is done so that adequate geographical dispersion is created of the vaccine recipients in the population, so that the levels of coverage will not be sufficient to reduce transmission (due to the trial). Even if the coverage levels do reduce transmission, this should ideally benefit both the vaccine recipients and non-vaccinees equally, so that the ratio of incidence of disease in vaccinees and non-vaccinees (which is the basis on which calculation of vaccine protective efficacy is done) will be similar to that recorded had the transmission not be reduced.[1]

Considering the importance of evidence regarding vaccine-induced herd effects to decisions about the introduction of new vaccines into routine immunization programmes; clinical trials of vaccines should be designed to assess not only direct vaccine protection but also vaccine-induced herd effects.[4] Advances in the design and analysis of vaccine trials with the endpoint being clinical disease, have now allowed us to assess a vaccine's ability to confer herd protective effects against important clinical outcomes, even prior to when a vaccine is licensed.[1]

Trial designs that randomize clusters of individuals rather than the individuals themselves, can assess both the direct and herd vaccine protective effects for a vaccine that has been designed to prevent an infection that is transmitted from person to person. In cluster-randomized trials, consenting eligible individuals within a cluster will receive the agent (vaccine or a placebo) assigned to the cluster.[1]

The potential suitability of both cluster-randomized and individually randomized trials for measurement of herd protection offers opportunities to assess the type of protection even before the vaccine is license and with greater protection against bias.

Further details on assessment of vaccine herd protection utilizing new approaches and measurement of vaccine herd protection will be elaborated upon in subsequent articles.

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Table 1: Selected notifiable diseases reported by Medical Officers of Health 02nd– 08th Sep 2023 (36th 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	84	11430	1	13	0	11	0	2	0	11	1	244	0	0	0	5	0	0	8	239	2	35	0	6	**39**	**100**
Gampaha	65	11541	2	19	0	14	0	7	0	5	11	432	0	8	1	15	0	0	10	218	7	88	1	36	**7**	**100**
Kalutara	70	4000	0	20	0	2	0	1	0	6	31	654	0	2	1	8	0	1	17	396	10	83	0	1	**31**	**100**
Kandy	201	5867	0	29	0	1	0	10	2	17	9	228	2	47	0	3	0	2	8	206	2	22	0	25	**89**	**100**
Matale	28	1304	0	2	0	3	0	1	1	14	1	123	0	13	0	5	0	0	0	50	1	5	6	243	**28**	**100**
NuwaraEliya	9	227	5	131	0	4	0	3	4	48	1	116	3	60	0	5	0	0	11	137	2	21	0	2	**63**	**100**
Galle	64	2234	2	39	0	13	0	5	0	24	21	741	1	57	1	2	0	1	8	259	2	23	0	3	**38**	**100**
Hambantota	25	1247	1	9	0	3	0	1	0	9	7	246	4	66	0	9	0	0	3	117	0	16	7	472	**31**	**100**
Matara	17	1548	1	21	0	8	0	1	0	17	10	437	1	30	0	5	0	2	8	240	0	16	2	141	**58**	**100**
Jaffna	31	1949	4	83	0	2	0	12	0	28	1	12	4	501	0	5	0	2	4	153	0	14	0	2	**66**	**93**
Kilinochchi	0	86	0	8	0	0	0	1	0	16	0	8	0	7	0	0	0	0	1	16	0	2	0	0	**32**	**100**
Mannar	1	79	0	6	0	0	0	1	0	0	2	34	0	5	0	0	0	0	0	2	0	8	0	0	**50**	**100**
Vavuniya	1	146	0	9	0	1	0	0	3	9	0	30	0	8	0	1	0	0	0	21	0	12	0	10	**18**	**100**
Mullaitivu	1	116	0	13	0	1	0	4	0	12	1	35	0	6	0	1	0	0	0	12	0	2	0	7	**24**	**100**
Batticaloa	9	2130	1	162	1	8	0	5	0	18	0	75	0	1	1	6	0	1	2	79	0	28	0	1	**65**	**100**
Ampara	2	211	1	7	0	1	0	1	0	52	0	112	0	2	0	1	0	0	0	62	1	42	0	6	**10**	**100**
Trincomalee	8	1992	2	21	0	1	0	1	0	65	0	61	0	15	0	3	0	0	1	56	3	28	0	2	**29**	**100**
Kurunegala	36	2551	0	38	5	15	0	1	0	6	5	320	1	16	0	9	0	2	21	424	11	163	8	412	**28**	**100**
Puttalam	19	2869	1	28	0	3	0	1	0	2	8	68	0	8	0	1	0	0	2	90	5	57	0	19	**28**	**99**
Anuradhapur	8	660	1	12	0	1	0	1	1	8	1	237	0	30	1	4	0	2	9	200	0	43	16	452	**29**	**100**
Polonnaruwa	2	516	0	13	0	5	0	1	0	11	2	146	1	6	0	12	0	0	2	70	0	16	2	325	**36**	**100**
Badulla	15	927	2	32	0	5	0	0	0	44	4	278	2	49	4	78	0	0	5	136	1	38	2	34	**67**	**100**
Monaragala	28	598	0	21	0	6	0	0	1	5	6	449	1	34	0	22	0	1	1	61	4	67	0	143	**29**	**100**
Ratnapura	50	1873	2	38	0	15	0	2	1	17	25	957	1	27	0	16	0	2	7	169	7	128	0	140	**37**	**100**
Kegalle	58	2594	2	22	0	2	0	2	1	15	16	549	1	36	0	5	0	0	13	347	6	68	0	34	**33**	**100**
Kalmune	6	1670	0	65	0	10	0	0	0	0	2	48	0	1	0	0	0	0	15	100	3	34	0	0	**49**	**100**
SRILANKA	**838**	**60365**	**28**	**861**	**6**	**135**	**0**	**64**	**14**	**459**	**165**	**6640**	**22**	**1035**	**9**	**221**	**0**	**16**	**156**	**3860**	**67**	**1059**	**44**	**2516**	**41**	**99**

Source: Weekly Returns of Communicable Diseases (esurvillance.epid.gov.lk). T=Timeliness refers to returns received on or before 08th Sep, 2023 Total number of reporting units 358 Number of reporting units data provided for the current week: 356 **C****-Completeness

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

Table 2: Vaccine-Preventable Diseases & AFP

02nd– 08th Sep 2023 (36th 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	00	01	00	00	00	00	00	00	01	02	66	55	20 %
Diphtheria	00	00	00	00	00	00	00	00	00	00	00	00	00	0 %
Mumps	01	00	03	01	00	01	00	01	02	09	04	171	63	171.4 %
Measles	19	00	08	03	00	01	01	00	06	38	00	378	16	2262.5 %
Rubella	01	00	00	00	00	00	00	00	00	01	00	04	00	0 %
CRS**	00	00	00	00	00	00	00	00	00	00	00	00	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	00	00	00	00	00	00	02	07	- 71.4 %
Whooping Cough	00	00	00	00	00	00	00	00	00	00	00	06	01	500 %
Tuberculosis	93	41	22	10	08	01	08	08	25	216	53	6377	4790	33.1%

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

Take prophylaxis medications for leptospirosis during the paddy cultivation and harvesting seasons.

It is provided free by the MOH office / Public Health Inspectors.

Comments and contributions for publication in the WER Sri Lanka are welcome. However, the editor reserves the right to accept or reject items for publication. All correspondence should be mailed to The Editor, WER Sri Lanka, Epidemiological Unit, P.O. Box 1567, Colombo or sent by E-mail to **chepid@sltnet.lk. Prior approval should be obtained from the Epidemiology Unit before publishing data in this publication**

ON STATE SERVICE

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