

Voice of the Expert

Herd Immunity

1. What is Herd Immunity?

Herd immunity refers to the indirect protection from infection conferred to susceptible individuals when a sufficiently large proportion of immune individuals exist in a population. Herd immunity can be achieved by two ways

- I. Vaccination
- II. Natural infection

The term “Herd immunity” was probably first coined by American veterinarians. In the first decade of the twentieth century, there was an epidemic of spontaneous abortion among cattle in the USA due to some infection. The then veterinarians like Adolph Eichhorn then envisioned a concept of “herd immunity” among cattle to protect farmers from livestock destruction. Thus, this was a term related to animal health, which was later incorporated into human public health.

2. What are the Elements contributing to Herd Immunity ?

Herd immunity is an important element in the balance between the host population and the micro-organism, and represents the degree to which the community is susceptible or not to an infectious agent. Herd immunity depends on the Basic Reproduction Number (R_0). R_0 is the average number of secondary infections caused by a single infectious individual when introduced into a completely susceptible population. R_0 for any infectious agent depends on population density, population structure, human behavior, and biological characteristics of the infectious agent.

Herd immunity can be measured either indirectly or directly.

I. Indirectly from the age distribution and incidence pattern of the disease if it is clinically distinct and reasonably common. Although it's not a very sensitive method.

II. Directly from assessments of immunity in defined population groups by antibody surveys (sero-survey) or by some other tests; these may show 'immunity gaps' and provide an early warning of

susceptibility in the population.

These measurements can also provide an estimate of burden and trend of disease, needs of vaccine, and impact of other preventive strategies within very short time frame.



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3. What is the difference between Herd Immunity and Herd Effect ?

Herd effect is the reduction of infection or disease in the unimmunised segment as a result of immunising a proportion of the population. Herd effect is determined by herd immunity as well as the force of transmission of the corresponding infection ie, Effective Reproduction rate.

4. What is R_0 value? What does it signify? How can we reduce the value of R_0 for a specific disease?

Pronounced “*R naught*”, the Basic reproduction number also called the basic reproduction ratio or rate (R_0) is an epidemiological tool used to describe the contagiousness of transmissibility of infectious agents. It signifies the average number of secondary infections caused by a single infectious individual when introduced into a completely susceptible population. R_0 is affected by various biological, socioeconomic and environmental factors that govern the transmission. It depends on population density, population structure, and differences in contact rates and hence can be reduced by reducing any of these.

The estimation of R_0 involves a complex procedure and is usually calculated based on three primary parameters viz. duration of contagiousness, likelihood of contact between infectious and susceptible person and contact rates. The value of R_0 is usually constant for a given situation. It cannot be reduced. With various pharmaceuticals and non-pharmaceutical measures we can reduce the effective reproduction number (R). The effective R depends on the population's current susceptibility and changes over time. For example, for COVID-19 we do not have any effective treatment

or vaccine till date. The only way to reduce effective R is through non-pharmaceutical measures.

5. What is Herd Immunity Threshold ?

The point at which the proportion of susceptible population falls below the threshold for transmission of infection is known as herd immunity threshold. Herd immunity threshold can be achieved by natural infection or vaccination. This could be calculated by the given formula:

$$\text{Herd immunity threshold} = 1 - 1/R_0$$

6. What are the advantages of Herd Immunity ?

Herd immunity can protect people who have not been infected or vaccinated. It is relevant in case of immunization in most of the diseases as it protects individuals who cannot be vaccinated as well, like immunocompromised individuals from getting infected.

The concept of applying herd immunity to human population was probably first done by British doctors like WWC Topley and Sheldon Dudley in the 1920s. At that time in Britain, there was a lot of mortality among school-age children from infectious diseases like measles, diphtheria and scarlet fever. These British doctors wondered whether the same principle of acquired immunity as seen in the livestock, can be applied to human children.

7. What are the disadvantages of Herd Immunity?

There is no disadvantage of herd immunity. It is the ultimate goal in control of many of the infectious diseases.

8. Herd immunity against other common infectious disease. Comment on it.

Many of the infectious diseases exhibit herd immunity. Once a proportion of population is infected, the rest of the people are indirectly protected. For example, the herd immunity for measles can be achieved when 90% of the population are infected. This value depends on the basic reproduction number (R_0) of the infectious agent.

Dudley was a medical administrator who vigorously pushed forward with the concept. As such, the British had already a significant history of animal symbolism for human conditions. Dudley considered human society to be divided into herds like animals. He wrote, "we can contrast the shoregoing herd with the sailor herd, or herds dwelling in hospitals can be compared with those who live in mental hospitals." Later, he even published a picture of school going boys and captioned it the "human herd".

9. What will be the Role of Herd Immunity to overcome COVID-19 and how will we achieve it ?

COVID-19 is a highly contagious disease where transmission occurs from one person to another. As mentioned earlier, herd immunity can be achieved either through natural infection or through vaccination. As we do not have an efficacious vaccine yet, currently the herd immunity can be achieved by natural infection.

Editorial note: The concept of allowing a slow steady infection in the "human herd" to achieve herd immunity is naturally a controversial concept. People are justifiably anxious about being guinea pigs for such social experiment. When some spokesperson of the English government uttered the name early this year, there was severe public backlash and the British government had to withdraw their comment soon. Even if the mortality of COVID-19 is 1%, in order to infect 60% of the population of India (1.4 billion), we need to allow infection of 840 million, with estimated mortality of 8.4 million!! Can we allow this for "greater good"? NEVER

10. When will we achieve Herd Immunity against COVID-19?

This is a very difficult question to answer. The herd immunity will not be achieved everywhere at once. It will differ for all the places. The sero prevalence is higher in urban slums than the non-slum areas and rural areas. This is due to the higher population density in urban slums. These areas will achieve herd immunity faster. In the rural areas the herd effect will take longer. Factors determining the spread of the infection will help in achieving herd immunity like overcrowding, higher mobility, increase in human to human interaction, etc.

11. Is it a good plan to be infected by COVID-19 just to "get over with it"? If no, why not?

COVID-19 is a mild disease in majority of cases. In few the disease may be severe and death may occur. The evidence from worldwide shows that we cannot prevent this disease, we can only delay the progression of disease for some time. The risk of infection to all including the vulnerable falls, as immunity builds in the population.

The best way to achieve herd immunity is focussed protection. Best approach that balances the risks and benefits of reaching herd immunity, is to allow those who are at lower risk of morbidity and death to live their lives normally so that immunity to the virus can be build through natural infection. This will protect those who are at highest risk.

With Covid-19, we are facing the same problem faced by the European doctors in the 1920s with Diphtheria. A highly contagious droplet infection with no vaccine or drug. How far should social distancing be enforced and is it feasible to allow some infection in the community?

12. We must slow down the disease process and check these preventable deaths. What should be the strategy ?

The various sero surveillance in parts of India show that the infection is widespread in the community. The

time to slow down the disease process successfully has already passed. Now the emphasis should be to provide best possible care to those who are in need. This way we can check many preventable deaths. Nonetheless continuing preventive control measures like face masks, physical distancing, hand washing, etc will slow down the disease progress.

There are a lot of controversies regarding herd immunity. we encourage the readers to go through other international publications like the excellent review of the topic in The Lancet by Jones et al on September 19, 2020. However, at this point, the editors of this journal do not recommend any strategy for herd immunity through natural infection. This is unethical and probably, would not be successful. India have had dengue and Chikungunya for at least the last 50 years. There is no drug or vaccine. Have Indians achieved herd immunity against these infections?

Also, India have had tuberculosis for thousands of years. There was no vaccine or drug till 1950s. There was hardly any social distancing. Did Indians get herd immunity? NO. India is still the country with highest number of new TB cases.

Thank you Dr. Sanjay K. Rai, for giving the invaluable insight regarding Herd Immunity.