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The Role of Herd Immunity in Control of Contagious Diseases

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ABSTRACT

Herd Immunity is a form which occurs when a large percentage of a population has become immune to an infection, whether through vaccination or previous infections so as to provide indirect protection against an infectious disease and can measure protection for individuals who are not immune to the infection. The Basic Reproduction number (R_0) is an important term which helps calculation to calculate the capability of an individual to infect an individual further and enables to discover the minimum amount of population coverage immune to develop herd immunity of that specific disease. When a critical proportion of the population becomes immune, called the herd immunity threshold (HIT), the infectious disease may no longer persist in the population, ceasing to be endemic at the end. Social networks however undergo constant growth, and it may be argued that network growth may change the level of herd immunity present in social networks. Vaccination helps prevent circulation of the infectious agents in susceptible population. High uptake and more effective the vaccine is more are the chances of success to eradicate infectious diseases like in the case of smallpox and polio. Herd immunity's inclusion in vaccination programmes makes it more favorable in cost-effectiveness or cost–benefit ratios and an increase in the number of disease cases avoided by due to vaccination. Herd or also known as Population Immunity is highly debatable subject and had different views by researchers regarding achievement of herd immunity in any disease control approach. In this article we have tried to enlighten the concepts regarding herd immunity; the diseases which can be accounted with it; its link with vaccination strategies and part of the disease eradication.

Keywords: Herd Immunity; Herd immunity threshold; Basic Reproductive number, Infectious disease; Vaccination

INTRODUCTION

When the immunity of a large proportion of the members in a susceptible population is developed against any infectious disease, spread of the transmission is ceased of and there is consequent lessening of the likelihood of an affected individual coming into contact with a susceptible individual. This is termed as Herd Immunity. [1] It consists of two words mainly Herd meaning a group or community and Immunity which has to be interpreted. The term immunity means is a state of resistance of an organism to invade biotic and abiotic pathogens and their harmful effects which prevents the spread of infection. [2] Herd Immunity is also called as Community Immunity; Population Immunity or Social Immunity. The Immunity can be tested for, as the presence of antibody, or as skin test or lymphocyte response to stimulation, against the chosen antigen. Herd immunity is quantifiable by testing a sample of the population forthe presence of the selected immune parameter. It is not dependent on the ease or difficulty of circulation of neither an infectious agent nor its elimination. It may be due to natural infection, or immunization, or a combination of both. [1] We can develop resistance naturally. When our body is exposed to a virus or bacteria, it makes antibodies to fight off the infection. When we recover, body keeps these antibodies. The body will defend against another infection and that was the reason which stopped the Zika virus outbreak in Brazil. Two years after the outbreak began, 63% of the population had had exposure to the virus. Researchers think the community reached the right level for herd immunity. Similarly vaccines can also build up resistance. They make your body think a virus or bacteria have infected it. You don't get sick, but your immune system still makes protective antibodies. The next time your body meets that bacteria or virus, it's ready to fight it off. This is what stopped polio in the United States. A community reaches herd immunity on the basis of calculation of reproduction number (R_0). It tells you the average number of people that a single person with the virus can infect if those people aren't already immune. The higher the R_0, the more people need to be resistant to reach herd immunity. [3] Herd protection: Protection to the unimmunized individual without inducing immunity, virtually by breaking the transmission of the infection or lessening the chances of susceptible coming in contact with infective individual. In a case when majority of a given population generally 80-90 % is immune to a contagious; or maybe infectious disease (spreads by any bacteria or virus) but are recovered through innate immunity by producing antibodies or can be achieved by vaccination. It is applicable only to the infections which spread from one person to another person .When any infectious disease in a large population liable to be immune spreads by the susceptible individual from person to person then there are less chances of the infection to be transmitted effectively as healthy immune individuals would act as an immunological barrier against the transmission in the community. Thus this immunized person gives back through namely through herd protection.

In clinical practice, herd immunity does not play significant role, while herd protection plays a major role, though to a limited extent, because unimmunized individuals do not develop immunity, but enjoy the protection because of break in spread of infection. Thus, the herd protection is the major beneficial component of immunization for an unimmunized population in an infectious disease. [4]

Figure 1 [33]: It states that Green: immune, Red: infected, Blue: not immune but protected due to herd immunity

It is proposed that herd effect be defined as the alteration of the epidemiological frequency parameters (of infection or disease as the case may be) in the unimmunized segment of a population as a result of immunizing a proportion of the population. The alteration is usually a decline of incidence of infection(hence lower incidence of disease). However, in the age group immunized there will always be a reduction of incidence of the infection if there was herd effect. In most, if not all other cases, herd effect of high herd immunity induced by immunization is beneficial in reducing the burden of disease; its extreme benefit is the interruption of transmission itself.

HISTORY

In 1923 W C Topsley and G S Wilson published a paper briefing series of experiments on populations of susceptible and immunized mice which was first to articulate a fundamental problems in infectious disease research and control came to a conclusion by firstly coining the term

'Herd Immunity'. [5] Moreover A W Hedrich recognized it as a naturally driven phenomenon in his research on epidemiology of measles in Baltimore while it came into effect in 1930's ; where the Research mainly emphasizes on fact that the number of new infections eventually decreased including susceptible population , when more number of the children were immune to measles. [6] Moreover a simple threshold theorem which used to calculate any particular disease's herd immunity threshold was recognized by Smith in 1970 & Dietz in 1975. [7] Herd Immunity came into consideration by the small pox eradication campaign in 1970's by the running practice of 'Ring Vaccination' where every person in the ring should be immune around the infected individual in order to prevent spreading of the infection. [8] Then Herd Immunity had gained broader after their connection with Mass vaccination programmes, cost–benefit analyses of vaccination, discussion topics on their integral role in disease eradication. [7] Thereafter since the adoption of mass and ring vaccination, complexities and challenges to herd immunity were been discovered. [7,8]

Phases of Herd Immunity

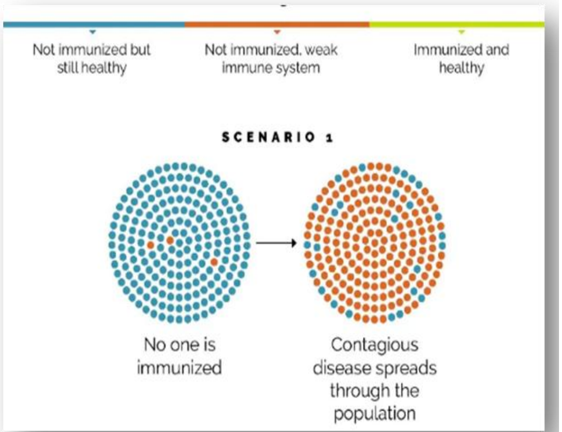

Figure 1: Phase I of Herd Immunity [9]

When a contagious disease enters an unvaccinated group, many members are affected as they lack immunity against the disease; an important element of it can be determined by the maturity and strength of an individual's system. For example very young children and elderly as well as very frail adults due to weak immune system might be more susceptible to the infections.

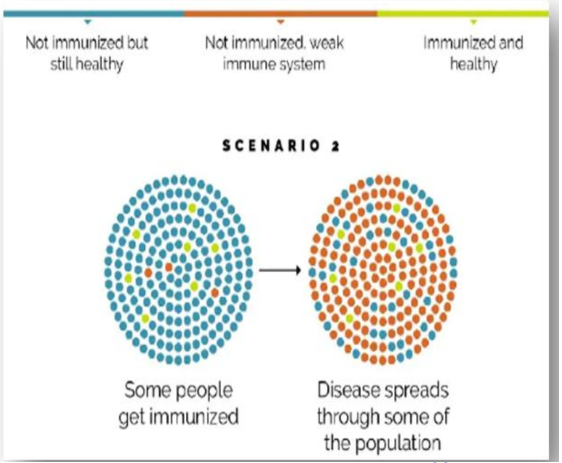

Figure 2: Phase II of Herd Immunity [9]

When only small percentage of population is vaccinated the risk of the outbreak of the disease is much greater than one in which most of them are vaccinated. The unvaccinated members of the population are not directly protected and each of the community member have higher risk of being infected.

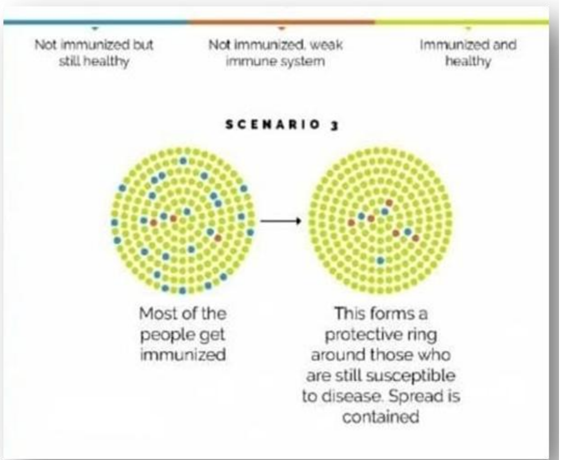

Figure 3: Phase III of Herd Immunity [9]

When a large percentage of population is vaccinated, the spread of disease is limited. This indirectly protects the unimmunized individuals including those who cannot be vaccinated and those for whom vaccination was not successful. When more of the population is vaccinated, the spread of infection is also less. If the number of immunized exceeds 80-95%; most likely the herd immunity's effect also increases. [10]

BASIC REPRODUCTION NUMBER

Basic Reproduction number (R_0): It is a fundamental statistic in epidemiology for the purpose of studying infectious disease dynamics to summarize a complex set of factors affecting the rate of transmission in a population. It is mainly number of secondary cases generated by a typical infectious individual when the rest of the population is susceptible (at the start of a novel outbreak). [11] Basic reproductive number varies differently from various types of infectious agents depending on factors such as: its life in through the environment, dose necessary for the infection, duration of infectiousness on host.

R_0 may also vary from population to population depending on factors such as population density, which may affect the number of effective contacts a person has while he/she is infectious. It may also vary with season for some infections, as the ambient conditions may affect the survival of the agent in the environment and the extent to which people have close contact with each other may be different in warmer and colder periods. The indirect protection that may be provided to unvaccinated persons if the level of herd immunity is increased by vaccination is illustrated schematically in Figure 5.

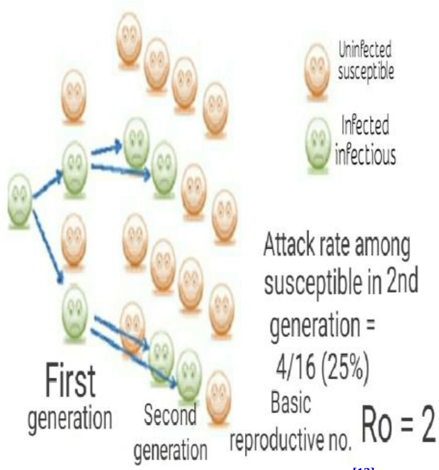

Figure 5: Scenario before Vaccination [13]

We consider an "idealized" population in which during the period of infectiousness an infectious person has contact with 4 other persons and with 2 of the 4 the contact is "close" enough for the infection to be transmitted. Here when the infectious person is introduced into a totally susceptible population, he or she infects 2 others (first generation) and then these 2 others each go on to infect a further 2 others of their 4 contacts (second generation) In this situation the basic reproductive number (R_0) is 2. Now consider the same situation after half of the population has been rendered immune to infection by vaccination, so that (on average) 2 out each person's 4 contacts will be not susceptible to infection.

Initially when any infectious person is introduced into the population only one infection results (first generation) as one of the contacts who previously would have been infected has been protected by vaccination. Similarly, the one newly infected person only goes on to infect one person (second generation) because half of the contacts have been directly protected by vaccination. In this situation the effective reproductive number (sometimes designated by "Re") is thus 1. Note the person circled in Figure 6. This person was infected in the scenario considered in Figure 1 but was not infected in the scenario considered in Figure 6, even though the person had not been vaccinated in Figure 6.

This is because the person was indirectly protected, as the person who would have infected them was themselves protected by vaccination and therefore did not pass the infection on. This is an illustration of a herd-protective effect of vaccination, where increasing the level of vaccination (in this case from zero to 50%) has reduced the risk of infection among the unvaccinated.

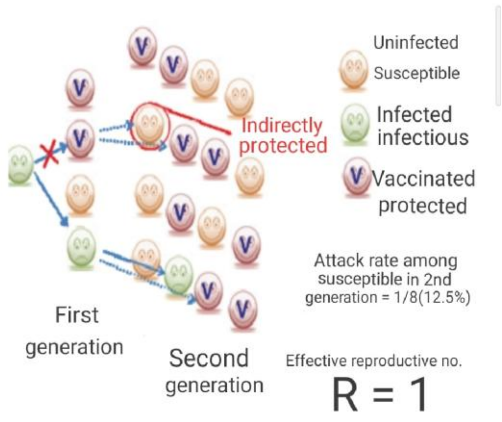

Figure 4: Scenario after Vaccination [13]

Thus, in Figure 5 the attack rate among susceptible in the second generation was 25% whereas in Fig2 it is 12.5% .When an infection which is transmitted from person to person, or for which humans are the principal reservoir, to be maintained in a population, each case of infection must give rise to at least one other case – i.e. the Effective Reproduction number(Re) must be above 1.R0 is an indication of the transmissibility of a virus, representing the average number of new infections generated by an infectious person in a susceptible population.

For R0 >1, the number infected is likely to increase, and for $R_0<1$, the transmission is likely to die out in the population. [12] Namely if the herd protective effect reduces the risk of infection among the uninfected sufficiently, then the infection will no longer be sustainable within the population and the infection will be eliminated. In general, the effective reproductive number (Re) will be lower than the basic reproductive number (R_0), depending on the proportion (P) of the population who are immune to infection. Such immunity may be induced either by a previous infection with the agent (if such infection produced immunity) and/or by immunization with an effective vaccine.

Simply, $R = (1\text{-}P) * R_0$. Therefore, for infection elimination or eradication – i.e. to reduce R below 1, then P must be equal to at least ($1\text{-}1/R_0$). So, for example, if R0 = 5 then P must be at least (1-1/5) = 0.8. That is, 80% of the population must be immune, either through previous infection or vaccination.

The value of P that reduces R to at most 1 is commonly called the "herd immunity threshold" – the level of population immunity that is necessary for the infection to be no longer self-sustaining in the population. The table mentioned below shows estimated values of R0 for some common infections and the derived values for the herd immunity thresholds using the formula given above. The higher the value of R0 the higher the level of population immunity required (often achieved by increasing population coverage with a vaccine against the agent) for disease elimination. Thus the required herd immunity threshold for infection elimination may be more complex to estimate that the simple formula given above. [13]

Table 1: Basic Reproduction number (R_0)and Herd Immunity Threshold (HIT) levels of various types of infectious diseases. [13]

Disease	Transmission	R_0	HIT
Measles	Airborne droplet	12–18	92–95%
Pertussis	Airborne droplet	12–17	92–94%
Influenza (influenza pandemics)	Airborne droplet	1.5–1.8	33–44%
Smallpox	Airborne droplet	5–7	80–86%
Polio	Fecal-oral route	5-7	80-86%
Mumps	Airborne droplet	4–7	75–86%
SARS [32] (2002–2004 SARS outbreak)	Airborne droplet	2–5	50–80%
Ebola [31] (Ebola virus epidemic in West Africa)	Bodily fluids	1.5–2.5	33–60%
COVID-19 [22] (COVID-19 pandemic)	Airborne droplet	1.4- 3.9	29–74%

Measles

Measles is a highly infectious and one of the most contagious viral diseases caused by the paramyxovirus family. It usually spreads through direct contact (close personal contact with infected nasal or throat secretions) or through airborne transmission (coughing and sneezing) which causes febrile illness typically in young children. [14,15] It is a human disease and is not known to occur in animals. It remains active and contagious in air up to2 hours; gets transmitted by an infected person from 4 days prior to the onset of the rash to 4 days after the rash erupts. [14] Each person with measles may go on to infect 9 to 18 others in a susceptible population according to the basic reproductive number calculated. [15]

Measles outbreaks can result in epidemics that cause many deaths, especially among young, malnourished children. More than 1,40,000 people died from measles in 2018 – mostly children under the age of 5 years, despite the availability of a safe and effective vaccine according to the report in MMWR. Global measles deaths have decreased by 73% from an estimated 5, 36,000 in 2000* to 1, 42,000 in 2018. In countries where measles has been largely eliminated, cases imported from other countries remain an important source of infection. All children diagnosed with measles should receive two doses of vitamin A supplements, given 24 hours apart as it restores low vitamin A levels during measles that occur even in well-nourished children and can help prevent eye damage and blindness which have shown to reduce the number of measles deaths. [14] The basic reproduction number R0 is estimated to be 12-18.

Measles is preventable by immunization but requires a very high vaccine uptake to maintain herd immunity. The need for maintenance of this high coverage to stop transmission requires a robust vaccination programmes to be followed. [16]

In 2018, measles caused an estimated 10 million cases. WHO recommends 95% coverage using two doses of measles vaccine to prevent the outbreaks. In 2018, only 86% 0f children globally received the first dose through routine immunization while in the second case, the coverage globally is just 69%. At 2.3 million, India is at second highest number of children who are not vaccinated against measles which is the report published in Morbidity and Mortality Weekly Report (MMWR). There were nearly 70,000 cases of measles in India in 2018, the third highest in the world. In 2019,over 29,000 confirmed cases have been reported to the WHO. The WHO recommends 95% coverage using two doses of measles vaccine to prevent the outbreaks. In Mass Immunization Campaigns are effective strategy for delivering vaccination to children who have otherwise been missed by routine services. [17]

Herd immunity, in the conventional sense of total protection of susceptible individuals by immunity in persons around them, is very difficult to establish against measles, because the virus is extremely contagious and a very high level of population immunity is required. However, population immunity affects the frequency of virus transmission and hence the age at infection. Immunity to measles derives from two sources: active immunization resulting from infection with wild or attenuated measles virus, and passive immunization by transplacentally acquired antibody. Active immunization makes the more important contribution to herd protection, but the duration of passive protection is quite variable, and it is important in providing protection during the most vulnerable age. [18]

INFLUENZA VACINE

Flu is a contagious respiratory illness caused by influenza viruses that infect the nose, throat, and sometimes the lung and symptoms include chills/cough, sore throat, runny or stuffy nose ,muscle or body aches, headaches and causes about 34,200 deaths according to CDC(Centre for Disease control and Prevention) USA. [19] The best way to prevent flu is by getting a flu vaccine each year. Flu vaccines are available every year before the flu season begins in the fall and everyone aged 6 months and older is recommended to get the vaccine. [20] Population including older people, young children, and people with certain health conditions like HIV/AIDS or Asthma or severe heart conditions or Cancer are at high risk of serious flu complications.

Influenza is a vaccine preventable disease. A trivalent inactivated influenza vaccine is most widely used and a cold adapted live attenuated influenza vaccine (LAIV) is also licensed in some countries. The efficacy of influenza vaccines against laboratory confirmed influenza is variable, most probably because of frequent drift of the virus. A systematic review confirmed overall 'moderate protection' of the vaccine. Some studies have also provided evidence of herd protection for the same. [21]

HERD IMMUNITY AND COVID-19

The initial cases of novel corona virus now known as COVID -19 were found in Wuhan, Hubei province, China since 29 December 2019 initially identified on the surveillance mechanism of "pneumonia with unknown etiology" which was discovered in the [SARS] Severe Acute Respiratory Syndrome outbreak in the year 2003 with the aim for the identification of novel pathogen. [22,23] It has spread worldwide triggering into pandemic. The basic reproduction number is a central concept in infectious disease epidemiology, indicating the risk of an infectious agent with respect to epidemic spread. [12] Covid-19's basic reproductive number has been derived to be median of 2.79.

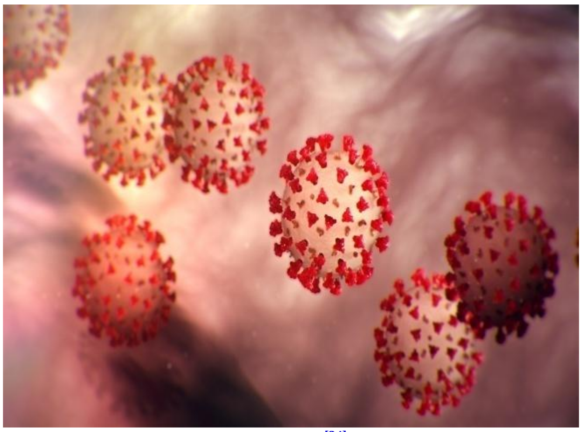

Figure 7 [34]

The basic reproductive number R0 enables the minimum percentage of population (Y) required to be immune for providing the herd immunity for the entire population. [7, 24]

Y= (R0– 1)/R0X 100

As per given data, R_0= 2-3 as per recent reports.

If R0= 2, then Y=[(2-1)/2]X100=50 %

Similarly, when R_0=3,

Then Y=[(3-1)/3*100=66.66 %.Therefore, for R0= 2-3, nearly 50 to 66.66 percent (threshold) of the populations required to be immune against COVID-19 for the protection of susceptible individuals in a given population through herd immunity. [24]

Since the onset of SARS-COV-2 spread, various studies have estimated the basic reproductive number (R0) of the virus to be in the range of 2 to 6. From an initial cohort of 425 confirmed cases in Wuhan, China, an R0 of approximately 2.2 was estimated, meaning that, on average, each infected individual gives rise to 2.2 other infections. More recent estimates place the R0 higher at 5.7, although many estimates fall within this range. This variation reflects the difficulty of obtaining accurate R0 estimates in an ongoing pandemic, and the current estimatedSARS-CoV2 R0 values likely do not indicate a complete picture of the transmission dynamics across all countries.

Assuming an R0 estimate of 2 for SARS-CoV-2, the herd immunity threshold is approximately 66.67%. This means that the incidence of infection will start to decline once the proportion of individuals with acquired immunity to SARS-CoV-2 in the population exceeds 0.66. As discussed above, this model relies on simplifying assumptions, such as homogeneous population mixing and uniform sterilizing immunity in recovered individuals across demographic groups, which are unlikely to hold true. Nevertheless, this basic model can give us a rough idea of the number of individuals that would need to be infected to achieve herd immunity in the absence of a vaccine given an approximate herd immunity threshold and a country's population. [25] The possibility of a mutation and emergence of a new strain of virus cannot be ruled out and it can make herd immunity ineffective although there is a chance of emergence of vaccination for the effective herd immunity. [24] ELISA can be calibrated to be specific for detecting and quantifying SARS-CoV-2 IgM and IgG and is highly sensitive for IgG from 10 days following first symptoms.

Numerous clinical trials to evaluate novel vaccine candidates and drug repurposing strategies for the prevention and treatment of SARS COV-2 infection are currently ongoing. However, it is unknown whether these trials will produce effective interventions, and it is unclear how long these studies will take to establish efficacy and safety, although an optimistic estimate for any vaccine trial is at least 12–18 months. In the absence of a vaccine, building up SARS-CoV-2 herd immunity through natural infection is theoretically possible. However, there is no straightforward, ethical path to reach this goal, as the societal consequences of achieving it is devastating that virus causes. [25]

The main obstacle to achieving COVID -19Herd Immunity is that virus that causes the disease is "novel" namely it hasn't infected humans before and everyone is at risk of infection and there is no inbuilt immunity existing against the virus. Yet More research is needed on it .As vaccine is yet to be discovered, a large number of population needs to be exposed and recover before we can have herd immunity .The only selective pressure on SARS-CoV-2 is transmission—stop transmission and you stop the virus .The linchpin for a strategy to move out of lockdown seemingly rests on increased testing and contact tracing, possible return-to-work permits based on immune status, repurposed or new therapeutics, and, finally, vaccination. Current discussion, addresses the notion that scaled up antibody testing will determine who is immune, thus giving an indication of the extent of herd immunity and confirming who could re-enter the workforce. Currently we should see the evidence-based assumptions on herd immunity, rather than optimistic guesses. [26] There is an urgent need for reliable antibody detection approaches to support diagnosis, vaccine development, safe release of individuals from quarantine, and population lock-down exit strategies. [27]

EBOLA VIRUS

Given that the recent 2014 Ebola epidemic had a lower R_0 values hence less vaccine coverage than previous epidemics would be needed in order to prevent transmission. For future plans Ebola virus transmission can be blocked by vaccinating susceptible populations. It is easiest to prevent an outbreak when a virus has a low R0value and high vaccine efficacy. [31] A Study suggest that Ebola viruses with $R0 \geq 3$ and vaccine effectiveness of 70%, (higher level) nearly all of the population would need to be vaccinated in order to establish herd immunity

It is important to note that there are several limitations to this study. The study utilizes a simple threshold theorem which makes several assumptions: (1) random vaccination within the population, (2) homogenous mixing of persons within the population, (3) homogeneous distribution of vaccine-induced protected and infected persons within the population, and (4) fully susceptible population. Currently, there are known contraindications to Ebola vaccination for specific age ranges. The phase 1 trial by sarwar was limited to adults aged 18–60 years. Due to the restrictions in age, a larger percentage of the adult population needs to be vaccinated in order to protect those who cannot be vaccinated. If children and older adults were also eligible to be vaccinated, it would be easier to reach the herd immunity threshold by being able to vaccinate more individuals. The most recent phase 3 trial of Ebola vaccination in Guinea involved ring vaccination in a cluster-randomized style. Ring vaccination involves administering vaccination only to a cluster of high risk individuals who are in close contact with a confirmed isolated infected person. Eligible individuals in the clusters were given either immediate or delayed Ebola vaccination. Of the immediately vaccinated individuals the vaccine was 100% effective as determined by no symptoms of ebolavirus disease 10 days after vaccination. Of all eligible individuals who received immediate or delayed vaccination (21 days after randomization) the vaccine was 75.1% effective and 76.3% effective spending on cluster. Because this was a cluster trial of individuals in close contact with isolated infected person(s) the R0valueof the virus is likely higher than in populations where individuals are not in close proximity. Therefore, it is possible that critical vaccination coverage values may be lower in other communities. Importantly, the basic reproductive value of the outbreak in Guinea was not reported so it is difficult to conclude exactly how the critical vaccination coverage would be affected. In future outbreaks with a 100% efficacious vaccine, as reported by the Guinea ring vaccination trial, 42–63% of the population would have to be vaccinated to prevent transmission. There are several stressors that could affect the ability to vaccinate individuals against Ebola in the future. When outbreak occurs, access to adequate supply of vaccine to vaccinate sufficient number of individuals is not always possible within desired time range to control transmission. Thus, it is important that future Ebola out-break protocols include intensive measures for containment to prevent transmission. If supply is a potential issue it would be wise to distribute vaccine supply in levels of priority. Similar to vaccination protocols within hospitals an important target population to vaccinate would be healthcare workers. The Guinea trial demonstrates the value of ring vaccination in Ebola and the importance of vaccinating individuals who have been or will be in close contact with the virus. This can include contacts of sick individuals such as family and friends, caregivers, and contacts of contacts. As clinical trials are still underway for development of Ebola vaccines, the consequences in future are awaited for the novel vaccine efficacy data to determine vaccine coverage needed to prevent outbreaks. [28]

VACCINATION AND VACCINE HESITANCY

Vaccination include partial or complete protection against symptomatic illness, improved quality of life and productivity, and prevention of death as well as overall benefits to society including creation and maintenance of herd immunity against communicable diseases, prevention of disease outbreaks, and reduction in health-care--related costs. [14]

A British Physician Andrew Wakefield published a study which claimed that there might be a link between the vaccine for measles, mumps, and rubella (MMR) and autism which is a developmental disorder in the year 1998. There is no such evidence proved; only small group researchers entertained this theory about autism and there were almost rare conflicts among the scientists regarding the debate. Although the trends were only coincidental, Wakefield’s paper helped run a debate in the media for about 15 years The paper got a growing concern amongst the parents in the US and UK about a possible connection between the rising number of childhood vaccinations and the rising rate of autism among kids due to which there was a fear among the population stoked by the media coverage which caused delay or decline in the vaccination of their children which led to increase in the measles infection gradually. [29] Education about herd immunity and local vaccination coverage could be a useful tool in increasing vaccination rates and benefiting communities. Vaccination protects individuals directly and communities indirectly by reducing transmission. [20]

If effective control of measles is to be attained in developing countries, a program must be designed to build on, and expand, herd immunity. [18] Vaccination risks range from common, minor, and local adverse effects to rare, severe, and life-threatening conditions. [14] To be biologically interpretable and to be robust to different transmission conditions and indirect effects, the parameters must take account of the type and amount of exposure to infection either by study design or by mathematical modeling. Otherwise, equivalent populations with the same transmission conditions could yield different efficacy estimates because of the indirect effects of vaccination. [30] Thus awareness regarding vaccination is needed amongst population to utilize its benefits to the fullest

DISCUSSION

When most of the populations in a community are immune to a particular infection that is spread from person to person, the natural transmission of the infection is effectively inhibited. Thus herd immunity indirectly protects people who have inadequate access to immunization and to people who remain unvaccinated by choice. People with multiple diseases at a time or those who are hospitalized could be benefited with Herd Immunity. Those group of people undergoing chemotherapy sessions or having disease like HIV which weakens the immune system are also been protected by achieving Herd Immunity. Herd Immunity generally applies only to diseases that are contagious; generally does not apply to diseases like tetanus, food born infections, intoxications etc.

Herd immunity also assumes; if a person is infected it will cause infection to others making them immune towards the disease. In India the polio has been eradicated in children because of herd immunity due to its effective integral mass vaccinations strategy. But in case of covid -19 herd immunity can only be achieved when 60-90 % of the population gets infected, then they tend to get immune and stop being the carriers of the virus and the remaining population which didn’t came into contact were indirectly been protected from virus . But in India it is highly dangerous due to overpopulation as we need to have a robust health care system with appropriate number of beds, ventilators, oxygen cylinders for those who are being to get infected. UK tried to adopt herd immunity for covid -19 but the cases went too far to control the virus. Recently Sweden also approached herd immunity thinking of having a strong healthcare system to approach. Earlier measles and polio were able to develop herd immunity by the help of vaccination and not just naturally. Vaccines were invented and vaccination camps were been introduced to immunize the children and help in vision to eradicate the disease. According to WHO only about 5 to 10% of the world’s population has been exposed to corona virus until now and experts say that India could develop herd immunity in 12 to 36 month time period. Still question arises that immunity developed against corona virus; will it persist for whole life period or few months or years we don’t know. So ideally it would be much better if we develop herd immunity with the help of vaccines. in many other cases there have been too many variable factors for herd immunity to be a success.

No matter how large the proportion of immunes in the total population, if some pockets of the community, such as low economic neighborhoods, contain a large enough number of susceptible among whom contacts are frequent, the epidemic potential in these neighborhoods will remain high. Success of a systematic immunization program requires knowledge of the age and subgroup distribution of the susceptible and maximum effort to reduce their concentration throughout the community, rather than only aiming to reach any specified overall proportion of the population".

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