COVID-19: The Concept of Herd Immunity – Is It A Strategy for South Africa?

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We are currently in the midst of probably the greatest challenge our fledgling nation has faced since the abolition of apartheid. This threat does not discriminate on the basis of race, colour, religion, gender, age or socioeconomic status. The current outbreak of the novel coronavirus SARS-CoV-2 (COVID-19) was declared a global health emergency by the World Health Organisation (WHO) in January 2020, while the United Nations has described this pandemic as the worst crisis that humanity has faced since the World War II.(1) Our President declared a state of disaster in South Africa on 26 March 2020, enforcing a military-supported national lockdown.

The concept of herd immunity was introduced with the widespread use of vaccines to protect against common, but severely debilitating illnesses, such as smallpox and polio, which are spread by human contact and for which humans, are a major reservoir of these viruses. Herd immunity refers to the protection of populations from these infections and is brought about by the presence of immunity against these infections in individuals present within a community. It represents the balance between an at-risk population and the microorganism. Conceptually, herd immunity is defined by a subpopulation of patients who have acquired active immunity from either previous infection or prophylactic immunization. These patients subsequently confer a degree of protection to the rest of the community by decreasing the burden of disease as well as the carriage of the organism within that population group.(2)

Herd immunity has been an effective tool in the fight against infectious pathogens. The widespread use of vaccinations has eradicated smallpox from the world and probably polio as well. This has been achieved by the concept of introducing herd immunity artificially by immunization against these two diseases. This concept has been widely applied to many other infectious diseases such as measles, rubella, influenza and others. The effectiveness of herd immunity is dependent on several epidemiological principles which include the following:

• The disease must carry a substantial health risk.
• The risk of contracting the disease must be high.
• The vaccine must be effective.
• The vaccine must be safe.(2)

The COVID-19 virus fits all the above principles, but there is currently no clinically proven vaccine against the virus.

Hence, what is all the fuss regarding herd immunity for COVID-19 in the absence of an effective vaccine? The problem with COVID-19 is that not only is it a highly infectious and contagious virus, but it is associated with a mortality of approximately 5.8% (9 April 2020) in confirmed cases.(3) Dense communities are particularly at risk. The crowding together of human beings, coupled with poor socioeconomic conditions, potentially places the African continent at particular risk for COVID-19. Additionally, very few African countries have sufficient and appropriate diagnostic capabilities. WHO has identified 13 top-priority countries in Africa which are at high risk for the spread of COVID-19 infection. South Africa, due to high volumes of international trade and travel, is also included in this list.(3) Furthermore, evidence from China suggests that both health-care resource availability and health-care burden (number of patients presenting with disease) correlate with mortality.(4) In many parts of Africa, including South Africa, the health-care sector is overburdened. This is largely due to infectious diseases such as tuberculosis (TB) and human immunodeficiency virus (HIV).
In response to this emerging health-care threat, most countries around the world began to lock down workplaces, schools and public gatherings. In contrast, the United Kingdom instead opted to limit new infections through gradual restrictions, rather than adopting stringent lockdown measures. Using mathematical modelling, they postulated a strategy with the aim of achieving herd immunity by allowing the disease to run rampant through their population. This strategy is similar to one that is achieved by a national vaccination programme in an attempt to build ‘herd immunity’. The rationale behind this theory is that by allowing ‘enough of citizens who are going to get mild illness to become immune’, a national disaster may be averted. Unfortunately, this strategy failed due to the high complication rates, as well as the short incubation period and lethality of COVID-19. The initial UK strategy led to high rates of hospitalization and intensive care unit admissions, thereby straining their current health service capacity beyond breaking point.(6)

Our understanding of the early transmission dynamics of COVID-19 and evaluating the effectiveness of control measures is crucial for determining the potential for sustained transmission to occur in new areas.(7) Among the first 425 patients in Wuhan, China, with confirmed COVID-19, the median age was reported as 59 years, 56% were male and the mean incubation period was 5.2 days (95% confidence interval [CI], 4.1–7.0), with the 95th percentile of the distribution at 12.5 days. In its early stages, the epidemic doubled in size every 7.4 days. With a mean serial interval of 7.5 days (95% CI, 5.3–19), the basic reproductive number was estimated to be 2.2 (95% CI, 1.4–3.9).(1)

Using a mathematical stochastic transmission dynamic model to multiple publicly available datasets on cases in Wuhan and internationally exported cases from Wuhan, it was estimated that just by introducing travel restrictions, the reproductive number would decline from 2.35 to 1.05 within 1 week.(7) With the aid of this data, many countries around the world have introduced national lockdowns, as well as the concept of social distancing and self-quarantine as appropriate measures to control the spread of COVID-19. The objective of this strategy is to potentially limit the strain on an already-overburdened health-care system – so-called flattening the curve.(8) South Africa has followed suit with its lock-down measures.

However, this strategy may not be potentially sustainable in a South African economy nearing collapse. In addition, upon the release of the national lockdown, there remains a high likelihood of a resurgence of newly diagnosed COVID-19 cases (Figure 1).(8) Most of the available reports to date indicate that children infected with COVID-19 are less symptomatic. Recent data reported from the Chinese Centre for Disease Control and Prevention indicated that among the 44,672 confirmed cases of COVID-19, as of 11 February 2020, 416 (0.9%) were aged 0–10 years and 549 (1.2%) were aged 11–20 years.(9) Furthermore, in a study of 44,672 confirmed COVID-19 cases of adults and children from China, South Korea, Italy and Spain (as on 11 February 2020), a total of 965 (2.2%) deaths were recorded, with only 1 death in the 10–19-year age group and no deaths in the 0–9-year age group.(9,10) The notable evidence from this data is that the burden of illness for COVID-19 lies predominantly in the patient age groups

**Fig 1: Illustrative simulations of a transmission model of COVID-19 (reprinted with permission from R. Anderson [8]). A baseline simulation with case isolation only (red); a simulation with social distancing in place throughout the epidemic, flattening the curve (green) and a simulation with more effective social distancing in place for a limited period only, typically followed by a resurgence when social distancing is halted (blue). These are not quantitative predictions but robust qualitative illustrations for a range of model choices.**
above the fifth decade of life (Figure 2).(11) The case fatality rate rose sharply with each decade of life above 50 years of age, with patients between the ages of 60 and 69 years having an average case fatality of 2.6%. Patients between the ages of 70 and 79 years had an average case fatality of 8% and patients above the age of 80 years had an average case fatality of 15.8%.(11)

In these statistics quoted above may lie a potential solution for South Africa. The median age of the South African population is 27.6 years with an average life expectancy of 64.8 years. Currently, 67% of the population reside within an urban environment.(12) This implies that we have a much younger population compared to countries such as Spain, Italy and England who have reported large numbers of COVID-19 related mortality. In South Africa, a hybrid model could be considered, wherein young children, adolescents and adults under the age of 50 years, without any significant comorbidities, are allowed to return to schools or universities, and for employed adults to return to their places of employment. It is imperative that this should take place in a setting where the country continues to follow all the precautionary measures of testing, surveillance, quarantine of infected individuals, social distancing, hygiene and very close support of the elderly at-risk population. The potential benefit of targeting this approach is that the cohort of the population under 50 years has the lowest case fatality rates for COVID-19. Furthermore, easing the lockdown within this economically productive segment of the population will make a significant impact in mitigating the negative long-term financial impact of COVID-19 on our fragile economy.

This phased approach may also help us to mitigate against the potential of the ‘re-emergence phenomenon’, where there is a sudden spike in the incidence of new COVID-19 cases (Figure 1).(13,14) The rationale of an approach of this nature would be for this young population of patients to acquire mild or asymptomatic disease with subsequent immune memory to COVID-19. This has the potential to disrupt the natural pattern of the spread of the illness within the population at large. In addition, this young population is less likely to pose a significant burden on the health-care sector as they have a high recovery rate and a very low case fatality rate.(15) A potential limitation to the implementation of this strategy is the unknown effect of COVID-19 on persons living with HIV and TB. However, there are preliminary reports that countries with the widespread use of the BCG vaccine seem to have a lower morbidity and mortality from COVID-19, thus potentially protecting our population.(16)

Unfortunately, the behaviour of SARS-CoV-2 has been unlike any other infection that we have previously been exposed to – and therefore there is no right or wrong answer. We can just postulate and hope for the best!

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