The Many Forms of Vaccine Hesitancy

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The COVID-19 pandemic has led to more than 176 million confirmed cases and over 3.8 million confirmed deaths. These numbers are likely dwarfed by the true rates of infection and death, which will remain unknown well into the future and will likely never be fully elucidated.[1] During this time, several countries have vied for the unhappy honour of being the worst affected by the pandemic, including Italy in early 2020, the United States through 2020 and early 2021, and most recently India in April and May of 2021.

The emergence of highly effective vaccines in late 2020 and early 2021 suggested some relief might be on the horizon. The optimism proved to be somewhat short-lived, as questions of vaccination and vaccine availability (not unanticipated, but now real) arose. India provides perhaps the most dramatic example: despite the initiation of vaccination programmes, India suffered a devastating second wave of infection and death in 2021 that eclipsed the relatively mild first wave of 2020.

With this second wave appearing to recede, and other parts of the world cautiously reopening, one of the most pressing questions related to the pandemic is surely whether we can exploit this respite and vaccinate as many individuals as possible, to delay or dampen future waves of SARS-CoV-2 infection. With this in mind, we can consider the total human population as either vaccinated or unvaccinated. Every individual whose status changes from unvaccinated to vaccinated represents a further step in controlling the pandemic. The unvaccinated group can in turn be divided into subpopulations of individuals who are involuntarily unvaccinated (for instance, because of being immunocompromised or lacking access to vaccines) and individuals who remain unvaccinated by choice. The latter group—comprising those unvaccinated by choice—may shortly become the main barrier to achieving the long-awaited herd immunity. The herd immunity threshold for any infectious disease is usually substantially lower than 100% population immunity. If vaccine-*hesitant* individuals can be persuaded to seek vaccination, it may be possible to acquire some form of herd immunity without needing to engage in the vastly more daunting task of persuading vaccine *refusers* to seek vaccination.[2]

In this essay I would like to examine some of the sources of vaccine hesitation I have observed amongst friends, family, and acquaintances in India. It would be preposterous to claim to speak 'for Indians' or provide a view on 'the Indian experience'. Rather, I relate some instances—largely from my own experience of the pandemic in India—to illustrate the types of vaccine hesitancy that might be operating in India and elsewhere in the world. My hope is to frame my observations in such a way that they may be amenable to more rigorous survey studies that could elucidate the distribution of these attitudes. My general point is that there are numerous types of vaccine hesitation, and many of these differ quite dramatically (in kind and not just degree) from the beliefs characterising the anti-vaccine movement.

Distinctions between vaccine hesitancy and anti-vaccine beliefs

Earlier, the phrase 'vaccine hesitancy' brought to my mind the image of an angry, ill-informed, unreasonable individual whose refusal to receive a vaccine put others at risk, delayed herd immunity at best, and at worst allowed new and more virulent SARS-CoV-2 variants to evolve. I have since found that such a stereotype is probably fairly common amongst pro-vaccine individuals. Whilst vaccine hesitancy may indeed increase the probability of these outcomes, there is significantly more nuance to the matter of vaccine hesitation than such a narrow stereotype can accommodate. Consequently, my own views on vaccine hesitancy have been broadened by its (at first alarming) frequency amongst friends and family.

1 Infection and death rates are almost always greater than confirmed cases. The best we can do is provide estimates for the true rates using information from confirmed cases, transmission dynamics, and mortality data.

2 I am not suggesting that vaccine refusers be ignored in public health discussions. Anti-vaccine attitudes put significant numbers of individuals at risk for several infectious diseases. Rather, my point is that addressing anti-vaccine beliefs is a longer-term project that goes beyond the administration of any one vaccine. Therefore, as a temporary measure to acquire herd immunity, it may be more fruitful to focus on the hesitant group.

Vaccine hesitancy itself is a rather slippery construct, and at the outset I would like to distinguish vaccine hesitation from anti-vaccine beliefs and vaccine refusal. The two concepts are very different, and may require very different policy solutions to achieve vaccination levels sufficient for herd immunity. Yet despite the enormous variation in attitude and motivation, all of these individuals technically belong to the 'unvaccinated' group.

Many Indians I know who reported hesitation over SARS-CoV-2 vaccines have readily accepted numerous vaccines for other diseases. This in itself is interesting, because vaccine hesitancy is typically studied in the context of attitudes toward vaccines in general, rather than toward any one vaccine. Indeed, India has experienced tremendous success with many of its previous vaccination drives. Both polio and smallpox were eradicated in India, and this has been aided by relatively low rates of vaccine hesitancy. To that extent, I have always perceived India to be a largely vaccine-accepting country. A school child with a cut or graze from any kind of metal will be swiftly administered a tetanus vaccine. Someone unfortunate enough to be bitten by a stray dog—not uncommon in India, it has happened to me and many others I know—will be administered the multi-dose, multi-week schedule of the rabies vaccine. And yet, vaccine hesitancy is occurring amongst individuals who are vaccinated for other diseases and who were perfectly happy to vaccinate their children. The hesitance therefore appears to be very specifically tied to the features of the COVID-19 vaccine, as opposed to a generalised distrust of vaccines. In contrast, anti-vaccine beliefs encompass all vaccines, and the SARS-CoV-2 vaccines are only the latest addition to a long list. Anti-vaccine beliefs entail concerns about a very broad range of side effects, including the widely held view that vaccines cause autism in young children—a view roundly rejected by the scientific and medical communities, and for which no rigorous scientific or medical evidence has yet been offered. The anti-vaccine claims pertaining to SARS-CoV-2 vaccines that have been receiving media attention include suggestions that the vaccines cause humans to become magnetised, that the vaccines contain tracking devices (which may interact with 5G telecommunication signals), that the vaccines will change human genes, and that vaccinated individuals shed proteins that are harmful to unvaccinated individuals. These beliefs are in turn frequently accompanied by statements about the overarching roles of the government and the pharmaceutical industry, including statements that the virus was manufactured as a bioweapon, that humans are being used as experimental animals, or that the virus itself is some form of hoax perpetrated to justify increases in state control, generate profits for pharmaceutical companies, or both. In general, the beliefs underlying vaccine refusal and the anti-vaccine movement are associated with a particularly robust intellectual framework (I use 'robust' to indicate not quality but resistance to change). If someone attempts to offer evidence against these claims, or merely state that these claims have limited or no evidence, the response is that the individual has fallen prey to propaganda and believes what the government wishes them to believe. In other words, the absence of evidence becomes a type of evidence.

What I have noticed amongst those who are unvaccinated in my own social network is a high degree of vaccine hesitancy, but very little anti-vaccine sentiment. Though vaccine refusers and vaccine-hesitant individuals both belong to the unvaccinated population, they are psychologically very different from each other. The outcome is the same—a delay in vaccination—but the psychological antecedents differ. 'Hesitation' means uncertainty or indecision between two courses of action, and vaccine hesitancy entails precisely such uncertainty and indecision. In contrast to the uncertainty that characterises vaccine hesitancy, vaccine refusal and anti-vaccine beliefs typically entail high degrees of certainty.

Sources and types of vaccine hesitancy

I will describe several different forms of vaccine hesitancy that I have personally encountered from October and November 2020—just after India's muted first wave, when discussions of imminent vaccines appeared to become fairly widespread in India, and individuals began contemplating whether or not they would accept vaccination—to late April and early May 2021—at the peak of India's devastating second wave, when vaccine hesitancy began crumbling in the face of the extraordinary numbers of cases and deaths. The various forms of vaccine hesitancy I have encountered are not mutually exclusive, and indeed, an individual may express several of these beliefs simultaneously. Moreover, these beliefs can interact with one another to produce complex vaccine hesitation profiles. This list is not intended to be exhaustive, either of my own experience or of the rather vast world of beliefs characterising vaccine hesitancy. Rather, it is intended to indicate the diversity of vaccine-hesitant beliefs, and how such beliefs might be formed or questioned. They contribute to the delay in seeking vaccination, but need not induce vaccine avoidance. In almost every case, these beliefs can be altered via exposure to correct (or at least less inaccurate) information.

Development time

In my experience, the most significant source of hesitancy toward SARS-CoV-2 vaccines arises from the unusually rapid development period. It normally takes at least a decade—usually more—to develop a vaccine. The broad public perception is that this vaccine was developed in just a few months. In general, it is insufficient to simply say 'trust the science' to individuals who express concern over the speed of vaccine development. After all, so many of our metaphors and aphorisms urge us to value the tortoise over the hare. This message is so ubiquitous that if something happens too quickly, it is frequently believed to have happened at the expense of quality. Psychologists refer to the speed–accuracy tradeoff, in which the two aspects of performance, speed and accuracy, are often inversely related. Indeed, the inverse relationship between quality and speed may run deeper than we realise. For instance, terms such as 'fast food' imply cheap, palatable, but ultimately low-quality food. An investment scheme that does too well too soon is suspected of being fraudulent. Novels written too quickly are relegated to 'airport fiction' and perceived to lack literary merit. Caffeine connoisseurs disdain 'instant' coffee. Older spirits are more expensive and prestigious than newer ones. Professors warn their graduate students that obtaining a doctorate is 'a marathon, not a sprint'. All of these, to some extent, allude to the potentially destructive or unhealthy effects of an emphasis on speed (or at the very least suggest a lack of quality or care). My point here is not that this general view is mistaken. I only wish to highlight that there seems to be a cultural sense of an inverse speed–quality relationship. I believe that this cultural sense has set the stage for suspicions about a very rapidly developed vaccine. In other words, given this cultural background, it was probably inevitable that the speed of vaccine development would lead to a situation in which the vaccines would contend with strong established beliefs about the low quality of quickly developed products.

These are all essentially concerns over quality and quality control. Two strategies might have been helpful in alleviating them—in addition to pointing out that none of the steps essential to measuring and ensuring vaccine safety was compromised.

First, there were cases in which 'base' vaccines had already been under development for many years. The development of the COVID-19 vaccine was simply a final, relatively small step that was taken after many years of research. This was the situation with the Oxford-AstraZeneca vaccine (which is presently the most widely administered vaccine in India). The researchers exploited an existing, rigorously developed platform as the basis for the SARS-CoV-2 vaccine.[3] This approach can also be applied to vaccinating against the new SARS-CoV-2 variants, as the appropriate viral genetic information can simply be 'edited' into the existing platform to produce a vaccine effective against that variant (though this has not yet been deemed necessary). In other words, the vaccine was *not* developed in just a few months, but was instead developed by making relatively minor and straightforward changes to a platform that had been developed over many years.

Second, it might have been helpful to highlight two features of viral genetics. The first of these is that SARS-CoV-2 is a virus with a relatively low rate of evolution, and only low to moderate genetic diversity,[4] even though RNA viruses do tend to have high mutation rates.[5] In contrast to this more nuanced view of the genetic diversity of SARS-CoV-2, the (very strong) public impression of the virus appears to be that it evolves extremely quickly and unpredictably. It is likely that the media has produced this perception of a rapidly evolving virus, in particular through its coverage of the emergence of new variants.[6] I suspect this belief will be borne out in any large-scale survey about the public understanding of COVID-19 and SARS-CoV-2. The second relevant feature of viral genetics is that the SARS-CoV-2 genome is relatively simple—rather less complex than those of many other viruses, including influenza viruses.[7] The relatively low rate of the virus' evolution and the relatively straightforward nature of its genetic information have also let scientists develop the vaccine quickly. Had these features of the virus been widely discussed in the media, I believe hesitation over the novel aspects of the vaccine would have been lower.

3 Specifically, researchers at the University of Oxford had modified an adenovirus (a different respiratory virus). This adenovirus, known as ChAdOx1, serves as the delivery mechanism, delivering specific genes from the novel coronavirus that train the recipient's immune system.

4 Bette Korber et al, 'Tracking changes in SARS-CoV-2 Spike: evidence that D614G increases infectivity of the COVID-19 virus' (2020) 182 Cell 812; Lucy van Dorp, Damien Richard, Cedric CS Tan, Liam P Shaw, Mislav Acman, and François Balloux, 'No evidence for increased transmissibility from recurrent mutations in SARS-CoV-2' (2020) 11(1) Nature Communications 1; Erik Volz et al, 'Evaluating the effects of SARS-CoV-2 Spike mutation D614G on transmissibility and pathogenicity' (2021) 184 Cell 64.

5 Siobain Duffy, 'Why are RNA virus mutation rates so damn high?' (2018) 16 PLoS Biology e3000003.

6 I am not suggesting that this was intentional—rather, it is the sense that has emerged from the nature of the media's coverage of the pandemic.

7 SARS-CoV-2 has a relatively large genome, but it is organised into a single segment of RNA. The present consensus is that there is currently only a single strain of the virus (keeping in mind that variants are not strains). In contrast, viruses such as the influenza virus are more complex, with high genetic diversity. The influenza virus genome is organised into eight distinct RNA segments, with four strains and multiple subtypes. These genetic differences contribute to the greater success of the SARS-CoV-2 vaccines compared to influenza vaccines, even though the latter have existed for much longer.

Adverse events

Unfortunately, there were some occurrences of fatal blood clotting following vaccination with the Oxford-AstraZeneca vaccine in Europe in early 2021.[8] The intense public scrutiny of vaccine development and distribution ensured immediate, widespread international coverage of any adverse events, and administration of the Oxford-AstraZeneca vaccine was suspended across Europe. This also appears to have caused a wave of uncertainty in India about the safety of the vaccine.

Concerns over blood clots reinforced concerns over the vaccine's rapid development. In other words, did the blood clots result from a vaccine development and production process that was so excessively ambitious and speedy that it overlooked a dangerous side-effect? Statistical patterns are against such an interpretation: an adverse event that occurs in only a handful of every few million cases will be nearly impossible to detect in even the largest clinical trials of, say, 60,000–70,000 volunteers (and most trials are significantly smaller). A vaccine trial involving some tens of thousands of volunteers would have at best a minimal chance of detecting an adverse event that occurs once or a few times per million doses. Alas, this type of dry statistical discussion seems to do little to assuage any concerns, and this is likely related to the human mind's extraordinary sensitivity to the likelihood of extremely unlikely events. This is precisely the sensitivity that insurance companies and lotteries thrive on. Conveying exactly how small the risk of clot formation is can be difficult, because it entails capturing, in a reasonable way, how small a probability one in a million actually is. I believe some examples can highlight the low risk by comparison. For instance, anyone would concede that one hour in an entire lifetime is very brief when compared to the total number of hours in that lifetime. Yet there are 700,800 hours in a life of 80 years, and one hour out of 80 years is still a larger number than one out of a million. Alternatively, simply pointing out the risks (including risk of blood clots) from other commonly used drugs could provide an illuminating comparison. For instance, the risk of blood clots from consuming birth control medication is significantly higher than any apparent risk of blood clots from vaccination.

Post-vaccination infections

There is an abundance of stories of individuals dying of COVID-19 after being fully vaccinated. Many of these are simply hearsay of the form 'I heard of someone who knew someone in Dubai who died after being fully vaccinated.'

Epidemiologically, breakthrough infections following SARS-CoV-2 vaccination are relatively rare, and deaths from breakthrough infections are *extremely* rare (though they are expected with some degree of predictability). However, their outsized coverage in the media instead gives the impression that such cases are rather common. Furthermore, there is often a lack of detail on the circumstances of these post-vaccination infections. For instance, knowledge of comorbidities is frequently absent from the frantic retelling of the story. Or, if an individual is diagnosed with COVID-19 one day after receiving the second dose of the vaccine, they were likely already infected before they received the vaccine. Vaccines do not kill virions that were previously present in the body, and if an individual becomes ill before the vaccine is able to sufficiently train the immune system to resist the virus, it is not even

8 Similar instances associated with the Johnson & Johnson vaccine also occurred in the United States.

a case of breakthrough infection. Unfortunately, such situations are distilled into the incorrect statement 'I heard of someone who got COVID-19 after getting both shots.' I wish I had counted the number of times I had heard some or the other version of this tale. The combination of fears over blood clots and stories of individuals falling ill or dying despite full vaccination seem to have produced an impression that the vaccines are both dangerous and ineffective. This is hardly conducive to reducing vaccine hesitancy.

Advice from doctors

Doctors occupy a curious and potent social niche that appears to guarantee them a sense of awe and reverence under many or most circumstances. Because of the value given to a doctor's opinion, there is a great deal of movement to encourage doctors to encourage their patients to seek vaccines. However, a doctor's advice can also fuel vaccine hesitancy to devastating effect, and I believe this has happened in India and likely elsewhere. A friend of mine who consulted no fewer than three doctors about whether she should be vaccinated in April 2021 provides a telling example.[9] Of the three doctors she communicated with, one said he did not wish to advise her either way and that it was her decision whether to seek vaccination or not. When such a statement is made by a doctor, it strikes me as equivalent to advice to avoid the vaccine. The other two outright advised against vaccination and instead said it was safer to wait. It is almost certain that these doctors have been consulted by, and given this advice to, many others as well. A doctor—the family physician, or a friend who happens to be a doctor—is probably the most trusted source of medical information and advice for a family, far more so than any national figure or government message. If the person you called for medical advice when your child swallowed kerosene tells you to avoid vaccination, it is not unlikely that you will avoid vaccination. That is the nature of human trust and prestige. If we are uncertain about a course of action, we seek out information from high-trust, knowledgeable individuals to help us resolve the uncertainty. Unlike many of the other sources of vaccine hesitancy, there does not seem to be any sort of specific informational antidote to a doctor's advice. While a doctor's advice to seek vaccination can be an informational antidote to vaccine hesitancy, there is little one can offer that will change someone's mind after a doctor has reinforced an initial hesitation. Because the advice of a doctor (especially one's own) is not lightly discarded, this is likely one of the most dangerous sources of vaccine hesitancy.

Evolution toward reduced virulence

Some individuals seem to believe that the virus will gradually evolve to become less virulent, and there is therefore no need to seek vaccination. Evolution toward lower virulence is not an unreasonable expectation. There are many circumstances in which viruses are thought to have become less virulent in human history. One area of medical and scientific opinion does hold that as COVID-19 transitions from a pandemic to an endemic human disease, the virulence of SARS-CoV-2 infection will decrease. At this point, we do not know if this will indeed be the case. The difficulty here is that of the *effective* population size (in this case, the size of the population that the pathogen can access). In our evolutionary past, populations were smaller, more dispersed, and less densely connected, and a highly virulent pathogen might become less virulent because of limited availability of hosts. If a pathogen killed its host, there were simply fewer potential hosts available to infect, and pathogen could face genetic extinction. Under circumstances of small effective populations, it was in the pathogen's 'interest' to evolve to be less virulent. Today, human groups are both much larger and much more connected. If a pathogen kills its hosts or makes them extremely ill, it is still readily able to infect new hosts. In other words, in a heavily populated and densely networked world, a limited population of hosts is no longer necessarily a constraint on virulence. Therefore, the same pressures of natural selection on viruses to become less virulent may not be present or may not operate as strongly. Indeed, where higher virulence is associated with greater rates of pathogen transmission (which increases the probability of infecting new hosts), there may even be an *increase* in virulence.[10] At this point, we simply do not know which of these will occur. It may very well be the case that the virus will become less virulent. However, waiting for several years in the hope that SARS-CoV-2 will become less virulent—which may only happen after COVID-19 has killed several million more individuals and left many others with severe post-infection syndromes—is far from an optimal strategy when vaccines are available.

Previous infection

Another source of vaccine hesitancy is having been previously infected with SARS-CoV-2. The attitude here is along the lines of, 'I've already had it so I can't get it again, so no point in putting something foreign into my body.' There is a grain of scientific accuracy in such a statement. The results from a large number of scientific studies leave little doubt that SARS-CoV-2 infection produces some form of immunity after recovery in the vast majority of cases.[11] [12] However, the belief that infection-induced immunity ('natural immunity') is sufficient to protect against any future infection may not be entirely correct. It is true that previously infected individuals should have relatively good protection—at least against severe disease—for at least several months after infection. The belief that this protection is permanent relies on 'chickenpox logic'. That is, once an individual contracts and recovers from chickenpox, infection-induced immunity is typically considered to be almost 100% for life, obviating the need for future vaccination. However, following chickenpox logic takes us far further afield than necessary. SARS-CoV-2 is a coronavirus that primarily affects the respiratory tract, and it is probably rather more sensible to ask if someone can be infected with multiple respiratory viruses over time. In my own experience, it has been sufficient simply to point out that individuals contract respiratory viruses—including the common cold, which is also caused by a coronavirus—fairly regularly, perhaps once or twice a year. In this particular case, reminding an individual of their own experience

9 This is not unusual in India. If one has the benefit of economic privilege, it is very easy to pick up the phone and call one or several doctors—many of whom are family friends—for advice.

10 Graham AW Rook, Fredrik Bäckhed, Bruce R Levin, Margaret J McFall-Ngai, and Angela R McLean, 'Evolution, human-microbe interactions, and life history plasticity' (2017) 390 The Lancet 521.

11 Jennifer M Dan et al, 'Immunological memory to SARS-CoV-2 assessed for up to 8 months after infection' (2021) 371 Science; Deborah Cromer, Jennifer A Juno, David Khoury, Arnold Reynaldi, Adam K Wheatley, Stephen J Kent, and Miles P Davenport, 'Prospects for durable immune control of SARS-CoV-2 and prevention of reinfection' (2021) 21 Nature Reviews Immunology 395; Lauren B Rodda et al, 'Functional SARS-CoV-2-specific immune memory persists after mild COVID-19' (2021) 184 Cell 169; Aurélien Sokal et al, 'Maturation and persistence of the anti-SARS-CoV-2 memory B cell response' (2021) 184 Cell 1201; Adam K Wheatley et al, 'Evolution of immune responses to SARS-CoV-2 in mild-moderate COVID-19' (2021) 12 Nature Communications 1.

12 There are some instances, mercifully rare, in which individuals have become reinfected shortly after the initial infection, shown severe symptoms, and died.

of multiple colds and other respiratory illnesses may be sufficient to demonstrate that post-infection immunity against COVID-19 is more likely a matter of months than of years. Recently initiated human challenge research will further elucidate the nature of immune protection and reinfection in COVID-19.[13]

Related to this is the belief that India has achieved herd immunity because of the number of individuals who have already been infected, and therefore that uninfected individuals are no longer in danger of infection and no longer need vaccination. This argument seemed to be particularly appealing in late January and mid-February of 2021, when the number of COVID-19 cases in India was falling steadily and swiftly, and vaccines were on the horizon. A similar belief may re-emerge following India's (currently receding) second wave, in which some estimates suggest that over 700 million individuals have been infected.[14] Moreover, vaccines are now available to the entire adult population, which also hastens the attainment of herd immunity. The belief that rapidly accumulating natural immunity (from the recent wave of infections) and vaccinal immunity can exempt one from seeking vaccination oneself may become widespread as vaccination rates continue to increase and the number of COVID-19 cases in India declines. However, as with the first wave, and as with individual immunity, this follows chickenpox logic: even if herd immunity is acquired through natural and vaccinal immunity, the natural component of this herd immunity may be temporary and subject to decay, with reinfections becoming possible several months later. Upon the loss of herd immunity, unvaccinated individuals will again become susceptible to infection.

Cold storage and site choice

Other sources of hesitation are more mundane. They include, for instance, concerns over a site's cold storage capacity. Many of the urban vaccination sites are in government schools (my own vaccination was at such a site). Several individuals I have spoken to are worried that these centres do not have adequate refrigeration to appropriately store the vaccine, and consequently, are potentially administering vaccines rendered ineffective by insufficient cooling. These individuals have repeatedly postponed vaccination. This is a fairly sensible concern, but it can probably be alleviated by pointing out that the vaccines can usually last for several hours after being taken out of refrigeration. Moreover, even during administration (when they are not refrigerated), the vials are kept on ice, which should ensure sufficiently cool temperatures. More generally, reassurance that these sites are following the recommended procedures will likely help in overcoming bias against particular sites for such reasons.

Nosocomial infection

There has also been a concern over nosocomial (hospital-acquired) SARS-CoV-2 infection. If hospitals are hotbeds of SARS-CoV-2 virions, is it not better to avoid visiting them, even for vaccination? Nosocomial infections can be an important source of disease. Avoiding hospitals for vaccination is probably not unwise, but it could become harmful if the majority of vaccinations are offered at hospitals (which has often been the case). I had mentioned earlier that different types of hesitation can interact with one another: one of my friends was concerned about nosocomial infection and did not wish to be vaccinated at a hospital. At the same time, she was concerned about cold storage capacity at non-hospital vaccine centres, and did not wish to be vaccinated at a government school (the main alternative to hospitals). Therefore, she was in the unfortunate situation of wanting vaccination but rejecting the sites at which vaccination was available.

The simplest route to vaccination may be to ensure that one is appropriately shielded while at the hospital or clinic—for instance by wearing two face masks and a face shield, not touching one's face during the visit, using ample hand sanitizer, and then bathing or washing one's hands and face vigorously after leaving the site.

Cost

Unlike in many other countries, private hospitals in India are permitted to charge vaccine seekers. Therefore, vaccines in India are available either free of cost at government schools and hospitals, or at significant expense at private hospitals. For instance, New Delhi's private hospitals are charging between Rs 780 and Rs 900 for Covishield, and Rs 1,250 for Covaxin. Given that two doses are required, individuals in New Delhi could pay anywhere from Rs 1,560 for two doses of Covishield to Rs 2,500 for two doses of Covaxin. Assuming a family of four or five, as well as some elderly relatives, the cost for complete vaccination can run into several thousand rupees per household, putting privatised vaccination beyond the reach of many. These individuals must then rely on the vaccines supplied free of charge. However, because the free vaccines are in significantly higher demand, it takes longer to secure a vaccination appointment, slowing down the entire process. At the time of writing, there is an excess of vaccine slots (many thousands) available across New Delhi's private hospitals,[15] but all of the appointments for free vaccines are completely booked. This suggests to me that anyone in New Delhi who can afford privatised vaccination has been vaccinated, but that many who are unable to afford privatised vaccination remain unvaccinated and searching for the occasional appointment for free vaccines.

Vaccine preference

Some individuals prefer one vaccine to another. The two most commonly available vaccines in India are the Oxford-AstraZeneca vaccine (sold as Covishield), and the domestically produced Covaxin (which uses a whole-virion approach to induce immunity). Throughout this period, Covishield has been produced and administered in far greater quantities than Covaxin. In the early stages of the vaccination programme in India, I observed that Covishield seemed to be preferred over Covaxin amongst

13 Researchers in the United Kingdom have now received research ethics approval to conduct human challenge studies in which researchers will experimentally induce COVID-19 in patients with SARS-CoV-2 infection. Individuals who have recovered from COVID-19 will be re-exposed to SARS-CoV-2 virions. This type of study will produce fine-grained data about a range of variables, including the viral load necessary to trigger infection and the body's immune response. These types of data will inform future development of vaccines and antiviral treatments, and will also let us understand immune dynamics in cases of reinfection.

14 Lazaro Gamio and James Glanz, 'Just how big could India's true covid toll be?' *The New York Times* (2021).

15 The sight of numerous free slots is still something of a novelty to me. I remember just a few weeks ago that it was nearly impossible to find vaccine appointments of any kind in New Delhi, and everyone in my family took turns trying to secure appointments on the centralised booking portal at <Cowin.gov.in>. Obtaining an appointment was considered a victory, and at any time thousands, or hundreds of thousands, of individuals across New Delhi and the adjoining areas would be competing for a handful of slots that would appear on the website sporadically across the day.

my acquaintances. There could be several reasons for this: the imprimatur of the University of Oxford; the fact that Covishield was approved by the World Health Organization and Covaxin was not (which is still the case); and the fact that Covaxin was released under emergency approval rather than full approval, with testing still underway. However, the tables now appear to have turned, as there are some reports that Covaxin may be more effective against the new variants that presently characterise COVID-19 in India. Moreover, the gap between doses for Covaxin is currently 4–6 weeks, whereas the gap between Covishield doses is now 12–16 weeks. The shorter time to full vaccination may have made Covaxin more attractive to many. Therefore, several individuals are now avoiding the amply available Covishield in order to wait for the less available Covaxin. This is not an issue of hesitation per se, as individuals are willing to be vaccinated, but it certainly contributes to a delay in seeking vaccination.

Vaccine hesitancy in rural India and amongst the poor

I have focussed on my own encounters of vaccine hesitancy amongst an urban, English-speaking group that also has access to extensive information from foreign sources. However, I would be remiss if I did not at least mention the significant and rather different counterpart of this urban vaccine hesitancy, which is the vaccine hesitancy observed in some parts of rural India.

Rural Indians are hardly strangers to extensive vaccination campaigns. In general, rural Indian communities appear to recognise the importance of vaccines and readily accept vaccination. Historically, these vaccination drives have mostly been extraordinarily successful, and have controlled virulent diseases in even very remote parts of the country. For example, as mentioned earlier, India eradicated polio and smallpox, diseases that are both more transmissible and more virulent than SARS-CoV-2. This success would have been impossible without rapid and widespread vaccine uptake across Indian communities, including rural communities.

The situation has been rather more grim with respect to the COVID-19 vaccines in at least some parts of rural India. There are now reports of individuals unwilling to take the vaccine because they believe it will render them impotent or infertile, or that it will kill them as part of a government population control measure. Some individuals seek assurance from medical professionals that there will be no long-term effects. Medical professionals are of course unable to provide such reassurance, and this hesitation is likely interpreted as evidence of the vaccine's ill effects.

The sources of these beliefs appear to be, as usual, online misinformation and the ever-churning rumour mill. I also suspect that these fears may represent echoes of previous experiences with government population control measures, notably the family planning policies implemented in the 1970s, which entailed millions of forced sterilisations. The poor were most severely affected, and these policies have since been viewed as major human rights abuses.

I believe such attitudes resemble aspects of both the vaccine hesitancy in urban, wealthy India, and American and British anti-vaccine movements. The resemblance to urban vaccine hesitancy lies in the fact that rural communities are extremely likely to have accepted other vaccines without incident or protest for other, well-known diseases. In other words, they are not fundamentally opposed to any and all vaccines, only to this particular vaccine. The resemblance to American and British anti-vaccine movements lies in the belief in some sort of government scheme intended to eliminate large segments of the population or render them incapable of reproducing. It is unclear what proportion of rural Indians holds such beliefs. Mapping their extent will be crucial in ensuring appropriate levels of vaccination.

The fate of vaccine hesitancy

Much of what I have described is now a thing of the past, since the devastating second wave appears to have soundly extinguished vaccine hesitancy (at least amongst wealthier, urban populations). Everyone in my acquaintance who was hesitant is now either partly or fully vaccinated. A small part of this movement away from vaccine hesitation to active vaccine seeking may have been triggered by exposure to high-quality information about the vaccine itself.[16] However, in my opinion, the vast majority of this change is attributable to the glut of images and coverage of the second wave in India. There are too many examples to enumerate, but they include: the striking images of long rows of funeral pyres; the loss of close family and friends; news about patients dying in cars as their relatives drive from hospital to hospital searching for oxygen; neighbourhood WhatsApp groups indicating the growing number of proximate deaths; social media acquaintances reaching out on their networks for a few doses of Remdesivir or an oxygen concentrator; rumours of black fungus entering the lungs of patients through ventilators; and doctors themselves dying in significant numbers. These types of information were largely absent from India's first wave, or were present in far lower quantities. They appear to have combined to create a sense of overwhelming dread during the second wave, sufficient to transform vaccine hesitancy into vaccine seeking. This too is a form of informational antidote, but in this case the information speaks to one's sense of fear, as opposed to initiating a weighing up of the risks and rewards of vaccination in which the latter eventually win. For a large segment of the vaccine-hesitant population, the task is to reduce that delay, and preferably at a lower social cost than the one paid in India. It should not have taken a national catastrophe to convince individuals that vaccination is the surest way to reduce personal risk and transition out of the pandemic.

In sum, vaccine-hesitant individuals can be thought of as information seekers looking to make a decision to accept or refuse the vaccine. In India it so happened that the social costs and coverage of the second wave pushed many vaccine-hesitant individuals to seek vaccines. However, there is also research on Internet trends that finds that pro-vaccine and anti-vaccine sources compete in the informational space, and that vaccine-hesitant individuals can rapidly become entangled with anti-vaccine beliefs.[17] As the unvaccinated population shrinks and the vaccinated population grows and we inch toward herd immunity, vaccine-hesitant individuals will play a critical role in determining whether we can acquire herd immunity. Vaccine hesitancy may rise again as the second wave recedes and the threat of disease becomes more of a memory. However, if vaccine-hesitant individuals are categorised as having anti-vaccine attitudes, and ridiculed and berated across traditional and social media, it will only foster us–them divides.

16 For example, that the risk of harmful side effects is extraordinarily low, that the risks of COVID-19 vastly outweigh any risks of the vaccine, that the vaccines were tested for safety, and that the vaccines *are* in fact stored in appropriate conditions.

17 Neil F Johnson et al, 'The online competition between pro-and anti-vaccination views' (2020) 582 Nature 230.

These could lead to delays in vaccine seeking, or worse, contribute to driving vaccine-hesitant individuals into accepting anti-vaccine beliefs. As I hope to have illustrated here, there are numerous forms of vaccine hesitancy, several arising from confusion over the vaccine or logistical issues, and many of them can likely be addressed with accurate information. Advertisements and information campaigns are not necessary for individuals with pro-vaccine beliefs. However, if herd immunity is to become a reality, vaccine-hesitant individuals must be drawn in, not pushed out.