Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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COVID-19 Vaccine Hesitancy: Shortening the Last Mile

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We offer three recommendations to increase coronavirus disease 2019 (COVID-19) vaccination rates. First, use communication campaigns leveraging evidence-based levers and argumentation tools with experts. Second, use behavioral insights to make vaccination more accessible. Third, help early adopters communicate about their decision to be vaccinated to accelerate the emergence of pro-vaccination norms.

Unprecedented research and development efforts, combined with recent technological advances, have allowed researchers to develop effective coronavirus disease 2019 (COVID-19) vaccines in record time.

However, proving that a COVID-19 vaccine is safe and effective can only be a turning-point if uptake is high enough to stop the circulation of the virus. According to models with a vaccine efficacy of 80%, the percentage of the population that needs to be vaccinated to reach herd immunity ranges from 75 to 90% (depending on factors such as the basic reproduction number R_0, vaccine-induced immunity duration, and whether vaccines prevent transmission) [1]. Current vaccination intentions are far from allowing this goal to be met. A significant fraction of the global population reports they are unwilling to get vaccinated and, while vaccine hesitancy fluctuates, it remains dangerously high in many countries[i]. As a result, and in spite of recent improvements in some countries, rates of vaccination intention remain below the percentage required for herd immunity in most countries[ii].

This raises the serious possibility that a significant chunk of the effort directed towards COVID-19 vaccine development might end up being wasted in the last mile. Rolling out efficient public health policies requires attention to first and last mile issues. The first mile is about identifying the best solution, the 'what': What is the best prophylactic or therapeutic solution? What is the most efficient vaccine? The last mile is about developing the best strategy to ensure the solution reaches its target, the 'how': How do we convince people to accept the treatment? How do we make treatments accessible? If the last mile is neglected, then the efforts spent to identify medical or technological solutions risk being wasted.

To anticipate and solve last mile issues, it is vital to identify barriers to vaccination uptake and to come up with a strategy that maximizes vaccine uptake. In every country for which there is data, people provide similar reasons to refuse potential COVID-19 vaccination (for example, in Canada[iii], or in France [2]; Table 1), and similar to the reasons reported for refusing seasonal flu vaccination [3], they also map the World Health Organization (WHO)-SAGE (Strategic Advisory Group of Experts on Immunization) 'Three C model' emphasizing that complacency, lack in confidence, and convenience issues impede vaccination. Moreover, in some countries at least, these reasons appear to vary little across sociodemographic groups [2]. Such commonalities across countries, sociodemographic groups, and infectious diseases license the development of a common strategy that capitalizes on previous research to increase vaccine uptake. We propose three main intervention routes, which should receive urgent research and governmental attention.

Test a Communication Campaign Addressing Vaccine Hesitancy

A mass media campaign is warranted by the facts that no group is spared by vaccine hesitancy and that the same reasons for hesitancy are provided by all sociodemographic groups. Mass media campaigns can be effective, but messages must be tested before being broadcasted. Our first recommendation is therefore to identify the most effective messages using solid methods (Box 1).

Previous research has identified several promising levers to reduce vaccine hesitancy. These include the motivation to be altruistic [4], emphasis on the dangers of the disease [5], and the anticipated regret not to have gotten vaccinated [6].

Although mass media campaigns have the benefit of reaching broad swathes of the population, their effects remain modest [7]. Discussion with a trusted source can be vastly more effective, in particular when health professionals are involved. One study found that human papillomavirus vaccine uptake went from 2 to 38% among boys whose parents had received a recommendation by a medical provider [8]. In another, an expert taking part in a Q&A reduced the percentage of audience members saying they would not get vaccinated against influenza type H1N1 from 75 to 55% [9]. It is thus important to design interventions at all scales and, when large effects are required, to make the best of the power of discussion to change minds. For example, in a recent study, a chatbot designed to address arguments against the COVID-19 vaccine had proved successful in shifting vaccination attitudes and behavioral intentions [10].

Use Behavioral Insights to Make Vaccination More Accessible

A communication campaign is necessary, but not sufficient, given the existence of important intention-to-action gaps in this domain. To close these gaps, vaccination

Table 1. Most Common Reasons for Opposing COVID-19 Vaccination

Personal situation	
	I don't feel concerned, because of age or health condition.
	It is a useless vaccine, COVID-19 is not very dangerous.
	Because of my physical condition, my health does not allow vaccination.
	I have been tested negative, I'm not sick, I have been sick and am immunized
Effectiveness	
	Lack of knowledge, I prefer to wait longer and to study it over the long term to see if it is really effective and safe.
	I prefer to treat myself in other ways, there are other treatments (hydroxychloroquine). Social distancing and other behavioral measures are sufficient. I am careful. I prefer to develop my own immunity.
	Because of the possibility of a mutation of the virus (so the vaccine would be less effective or not effective at all).
Lack of trust	
	Because a vaccine developed in an emergency is potentially dangerous, side effects are unknown, and people can get sick.
	Because of my distrust of the pharmaceutical industry/medical profession, the laboratories are in a logic of profitability.
	Because of a lack of information, divergent opinions, no scientific consensus.
	Because there are secret relationships between the government and the pharmaceutical industry (opinions/conspiracy theories).
	Because of the poor management of vaccines and/or masks by the government (negative opinions/comments regarding the government and its management of the epidemic).
Antivax	
	I am against vaccination (in general), I don't get vaccinated.
	Because vaccines are (possibly) harmful, because of the impact of vaccines on health.

should be free and easy to access. Lifting barriers that are known to make vaccination inconvenient should increase uptake among those who are already in favor of getting a COVID-19 vaccine and among those whose intentions will have been changed in response to the communication campaign. Practically, the following steps could be taken, in combination.

First, to minimize the hassle factor, the vaccine should be offered free of charge, with no prescription requirement. Once a vaccine is available in large quantities, wide accessibility in familiar places should be offered, for example, by rerouting COVID-19 testing centers into vaccination centers.

Second, doctors should be encouraged to stock the vaccine so that people who visit their general practitioner (GP) for other health reasons can get vaccinated without having actively seek the vaccine. This would also allow provider recommendations to be more potent. In addition, studies have found that people prescheduled for a flu vaccine appointment were more likely to get vaccinated, even though they could cancel their preset appointment if they did not want it [11]. Onsite vaccination in the workplace has also been identified as a key lever. This underlines the power of defaults and simplification in helping people close the intention-to-action gap.

Finally, a large body of work demonstrates that reminders and prompts sent in a timely manner increase uptake [12]. This can take various forms depending on the target population, for example, text messages to remind parents that it is time for their child to receive a vaccine, emails or postcards to remind adults of the yearly influenza vaccination campaign, or even phone calls from healthcare providers. In the case of the COVID-19 vaccine, these methods should be leveraged to target priority populations, with particular attention to people from lower socioeconomic backgrounds who may otherwise be less informed.

Box 1. How to Test a COVID-19 Vaccine Messaging Strategy

(i) Use the literature to identify plausibly effective messages and modes of delivery (standard messaging [4–6], in person discussion [8,9], chatbot [10]).
(ii) Identify the outcome of interest: vaccination rates, or proxies such as vaccination attitudes and intentions, or motivation to transmit pro-vaccination messages.
(iii) Choose a sample. If the main interest is the effect of a message compared with no persuasive message, large convenience samples (e.g., recruited through crowdsourcing) should be sufficient. Otherwise, use a representative or other relevant sample.
(iv) Preregister the experiment and the analysis plan. Include analyses of subpopulations of interest, such as the most vaccine-hesitant individuals, or individuals with different levels of trust in the government, to test whether any backfire effect is observed among them. This is particularly relevant if the population's positions regarding vaccination are politically polarized[iv].
(v) Conduct an experiment with a control group receiving a nonpersuasive message (e.g., [10]). If measuring attitudes and intentions, pre- and postmessaging measures might create task demands, but are more informative. If possible, conduct a second wave after a delay to test for the durability of any effect. After the last postmessaging measures, give the message to the control group.

Leverage the Power of Social Norms

Because individuals learn about social norms in part by observing others, helping early adopters of the COVID-19 vaccine display their pro-vaccination choice or intention, for example, by providing easy access to badges or ribbons, might have a positive influence on the decisions of others. Previous studies in hospital settings

have found that having vaccinated health-workers wear a badge reading 'I am vaccinated against influenza to protect you' increased vaccination rates [13]. A similar result was found in a Dutch hospital, with an additional down-the-road effect on patient pneumonia and influenza morbidity [14]. These examples demonstrate that simply making positive decisions visible can be a powerful lever of change.

In order to trigger this virtuous cycle, it is important to ensure that people have an accurate representation of the actual level of support vaccination enjoys. Pluralistic ignorance, which occurs when people underestimate or overestimate the frequency of a given behavior in the population, can slow down change. Displaying true social norms or the upward dynamics of an emerging social norm can be a powerful engine to bootstrap health behavior change. For example, informing doctors who overprescribe antibiotics that they are further away from the norm than they think reduced over-prescription in a matter of weeks. Informing people about social norms around condom use, exercising, smoking cessation, or vaccination has also been found to be an effective way of changing individual behaviors. Social norms should therefore be leveraged both towards health-care providers and towards the general population.

Concluding Remarks

In high income countries, permanent refusal of all vaccines is rare, typically no more than 1 or 2% of the population, and studies have shown that many people who initially refuse a vaccine eventually change their mind [15]. This suggests that, for the vast majority of the population, the 'enlightened preference', that is, the preference formed under full information, is to be vaccinated. However, how quickly we get most of the population vaccinated will have a huge impact on the final death toll. The next few months are crucial to solve last mile issues, leveraging early adopters to overcome vaccine hesitancy. We owe it to the researchers who have worked tirelessly on developing a vaccine in record time to ensure that people are well-informed about vaccination and that they can turn their vaccination intentions into action as easily as possible, so that the last mile does not end up being longer than the first.

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Declaration of Interests

No interests are declared.

Resources

[i]www3.weforum.org/docs/WEF_survey_vaccine_confidence_2020.pdf

[ii]www.ipsos.com/sites/default/files/ct/news/documents/2020-12/global-attitudes-on-a-covid-19-vaccine-december-2020-report.pdf

[iii]www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00073-eng.htm

[iv]www.pewresearch.org/science/2020/12/03/intent-to-get-a-covid-19-vaccine-rises-to-60-as-confidence-in-research-and-development-process-increases/

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Beyond Job Burnout: Parental Burnout!

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Here, we lift the veil on an existing but long taboo phenomenon: parental burnout (PB), an exhaustion syndrome related to the parenting role. PB is caused by a perceived gap between parenting resources and demands, and has a host of serious consequences for both parents and their children.

Beyond Job Burnout: Parental Burnout!

Parenthood can usher in the best of times. It can also usher in the worst of times. Parenting can be a life-affirming and deeply