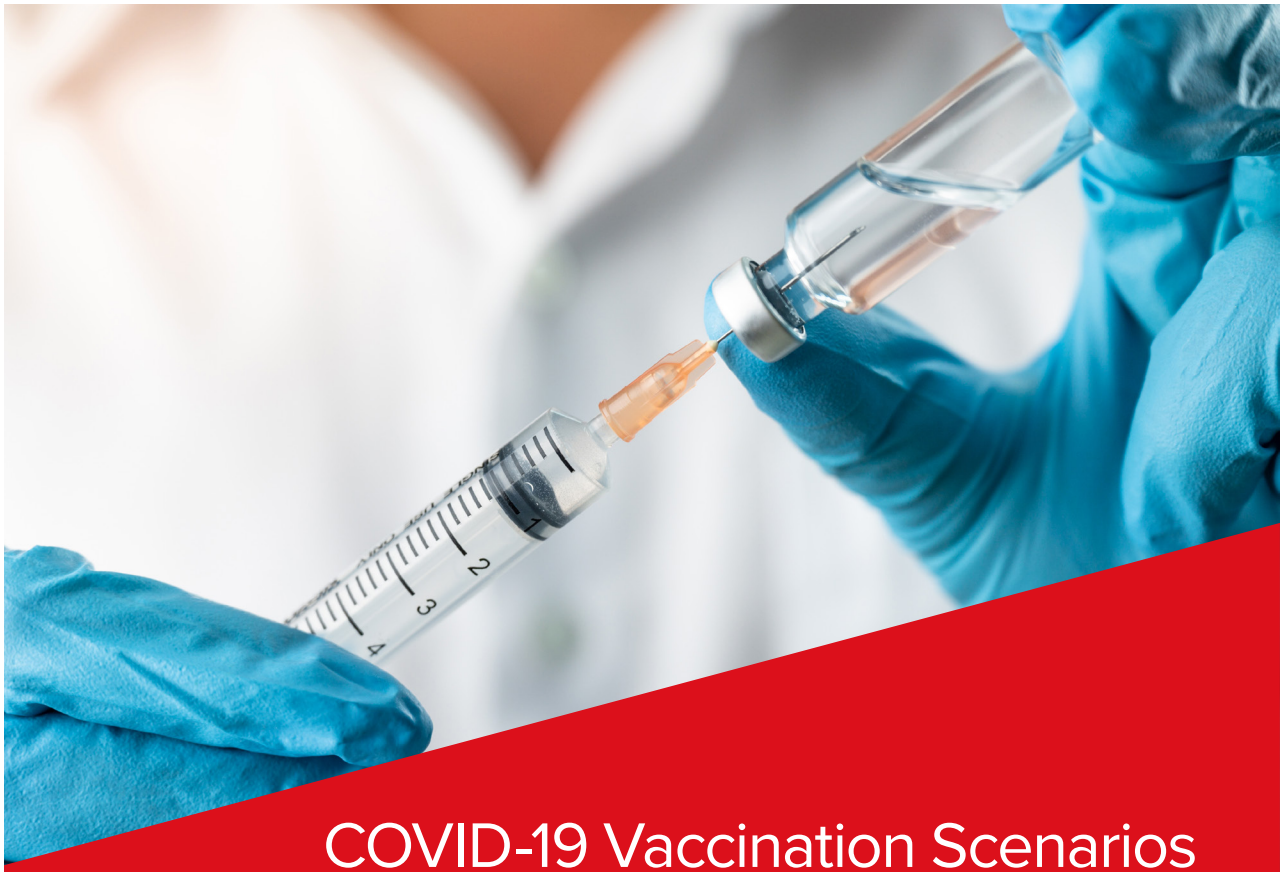

COVID-19 Vaccination Scenarios for 2021 and Implications for Life (Re)Insurers: U.S., U.K., and Canada

Chris Falkous, Biometric Research Actuary
Richard Russell, Lead Health Data Scientist
Dr. Daniel Zimmerman, Head of Global Medical

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Executive summary

As of this writing, optimism abounds that the first COVID-19 vaccine will be approved soon. Interim trial results announced by Pfizer and BioNTech on November 9 and Moderna on November 16 showed their vaccines to be over 90% effective against COVID-19. Pfizer and BioNTech subsequently announced on November 18 that their Phase III trial was now complete, and applied to the U.S. Food and Drug Administration for an Emergency Use Authorization for their vaccine on November 20. On November 23, interim trial results from AstraZeneca and Oxford showed vaccine efficacy of 90% under one of the dosing regimens being tested in their Phase III trial; AstraZeneca is now submitting these results to regulatory authorities.

Countries around the world have been busy preparing COVID-19 vaccination strategies for widespread vaccine deployment in attempts to ensure:

- **Capacity of vaccination services:** including a skilled workforce to deliver the vaccines and medical and protective equipment
- **Prioritization of target populations:** identifying who should receive the vaccines first and making access easy and affordable
- **Vaccines are not "wasted" or "degraded" during distribution:** addressing storage and transport needs for different vaccine candidates, including cold chain infrastructure, cooled transport, and storage capacity
- **As many people as possible choose to accept COVID-19 inoculation:** building public trust in COVID-19 vaccines through clear communications that educate people regarding the benefits, risks, and importance of COVID-19 vaccines when choosing to accept inoculation

To expedite vaccine deployment, the U.S., U.K., and Canada have entered into pre-authorization deals with several COVID-19 vaccine manufacturers. A number of these deals are sufficient, either on their own or in combination with other deals, to vaccinate at least 90% of each country's population.

Organizations in the U.S. and U.K. have indicated how a COVID-19 vaccine should be rolled out across different priority groups within their populations.

Even if a safe and effective vaccine were available, in many countries as many as 20-40% of the population may choose not to take it. This is broadly consistent with current take-up rates for the seasonal influenza vaccine.

This data can be used to generate scenarios for the potential level of vaccine-induced immunity in the U.S., U.K., and Canada by the end of 2021.

Reaching an assumed herd immunity threshold of approximately 60-70% in 2021 will likely require: vaccine take-up rates to be higher than generally seen for seasonal influenza, the vaccine to be around 70% effective (or better) at preventing transmission, and either multiple vaccines to be authorized or vaccine manufacturing capacity to be increased. None of these is guaranteed, but a significant portion of the population will likely be vaccinated throughout 2021. Even if herd immunity is not achieved in 2021, it appears that vaccines have the potential to be very effective at reducing severe COVID-19 disease, which would significantly reduce mortality risk. However, given the uncertainty around how long vaccine-induced immunity might last, life (re)insurers should be prepared for the possibility of ongoing COVID-19 mortality risk to some degree in 2022 and beyond.

As any vaccine is rolled out across different priority groups in 2021, the profile of those exposed to risk of infection and severe disease will change and will need to be reflected in forward-looking assumptions for infections and infection fatality rates.

Introduction

Following the favorable interim trial results announced by Pfizer[1] and BioNTech on November 9, Moderna[2] on November 16, and AstraZeneca[3] and Oxford on November 23, progress in the development of a COVID-19 vaccine has become one of the few sources of genuinely good news since the start of this pandemic. A process that can take up to 10 years from initial exploration through clinical development to regulatory approval has been accelerated so effectively that 11 candidates have already reached Phase III trials, with one of those (BioNTech/Pfizer) having completed Phase III. Behind those 11 are another 200 or so at earlier stages of development. These vaccines follow a range of different approaches, from the traditional to the new and untested. Those two factors – the sheer number of candidates and the range of different approaches – have fueled optimism that the first COVID-19 vaccine will be approved soon. In fact, Pfizer and BioNTech announced on November 18 that their Phase III trial was now complete, and applied to the U.S. Food and Drug Administration for an Emergency Use Authorization on November 20.

While this positive news is welcome, significant issues must still be addressed:

- The duration of vaccine-induced immunity
- The under-representation of certain subgroups in current Phase III trials, such as the elderly
- Understanding whether current vaccines are safe for children and pregnant women
- Public trust in a COVID-19 vaccine and uncertainty around take-up rates

In addition, the deployment of a vaccine to a global population of 7.8 billion across almost 200 countries has been described as the challenge of a lifetime.[4]

This paper discusses some of these issues and takes a data-driven approach to generating scenarios for potential vaccination rates by the end of 2021 in the U.S., U.K., and Canada.

Phase III trials

According to the World Health Organization (WHO), 11 candidates are currently in or have recently completed Phase III trials.[5] See Table 1.

Most are two-dose vaccines, usually requiring a second dose to be administered approximately 21 or 28 days after the first dose. Requiring two doses rather than one significantly increases the logistical challenge of distributing the vaccine around the world. It also raises concerns regarding public compliance with a two-dose protocol.

Table 1: Current List of COVID-19 Vaccines in Phase III Trials or Beyond per the WHO

Developer/Manufacturer	Approach	Doses	Capacity to End 2021
Moderna	mRNA	2	950m
BioNTech/Pfizer	mRNA	2	1,300m
CanSino Biologics	Adenovirus vector	1	N/A
Johnson & Johnson (Janssen)	Adenovirus vector	1	1,100m
Oxford/AstraZeneca	Adenovirus vector	1	2,940m
Novavax	Protein subunit nanoparticle	2	1,350m
Sinopharm/Wuhan	Inactivated virus	2	N/A
Sinopharm/Beijing	Inactivated virus	2	N/A
Sinovac	Inactivated virus	2	350m
Gamaleya	Adenovirus vector	2	100m
Bharat Biotech	Inactivated virus	2	N/A

Most of the manufacturers with Phase III vaccines have publicly announced estimates of how many doses they expect to be able to produce by the end of 2021 should their vaccine prove successful.[6] For example, Pfizer expects to be able to produce 1.3 billion doses by the end of 2021, which would be enough to vaccinate 650 million individuals with the two-dose vaccination.

Vaccine effectiveness

Phase III trials aim to demonstrate vaccine safety and effectiveness. Vaccine effectiveness refers to the percentage reduction in the rate of "events" in the unvaccinated group compared to the vaccinated group. For example, if the unvaccinated group experienced events at a rate of 20 per 100 and the vaccinated group experienced events at the rate of 5 per 100, then the vaccine would be 75% effective.

While unusual for typical vaccine clinical trials, four of the vaccine developers currently in or having completed Phase III trials – Moderna, Pfizer, AstraZeneca, and Johnson & Johnson (Janssen) – have released their Phase III study protocols.[7] The primary events occurring in these trials are cases of symptomatic COVID-19 disease: the combination of a positive COVID-19 test plus a symptom, such as a cough.

Regulators have indicated they will be looking for Phase III trials to demonstrate vaccine effectiveness of 50% or higher. As there is always uncertainty associated with trial results – think of confidence intervals around point estimates – demonstrating 50% vaccine effectiveness in Phase III means that one can be confident that the vaccine is truly at least 30% effective (based on the number of participants in the trials and the number of events required before the trials end). Remarkably, vaccines from Pfizer/BioNTech, Moderna, and AstraZeneca/Oxford (for one dosing regimen) appear to be at least 90% effective at reducing symptomatic COVID-19 disease.

Using symptomatic COVID-19 disease as the primary endpoint for the trials makes sense when trying to conduct the Phase III trials as quickly as possible, since most people – 80% or more – will experience a mild form of the disease. A consequence of this is that less will be learned from the initial trial results about how effective the vaccine is in protecting against infection or reducing the severity of disease and, therefore, mortality. This is a particular problem for the older, higher-risk population, since potential under-representation in the Phase III trials and low numbers of cases mean it will be some time yet before we can be confident in how well the vaccine works in this subgroup. Promisingly, the Pfizer/BioNTech news release indicated the observed efficacy in adults over 65 years of age was over 94%, and both the Pfizer/BioNTech and Moderna vaccines seem to be over 90% effective in preventing severe COVID-19 disease, although further data will be needed to confirm this. The interim results from AstraZeneca/Oxford reported no hospitalizations or severe cases of COVID-19 in the vaccinated group.

There were concerns that, in theory, it would be possible that the first authorized vaccine could have little impact on preventing infection, yet be effective at reducing symptoms in mild disease (so vaccinated individuals would be more likely to get asymptomatic disease) while having no impact on severe disease and mortality in the older population; such a vaccine would make it more difficult to detect and prevent transmission of the virus. Fortunately, the results announced by Pfizer/BioNTech and Moderna suggest that this scenario will not occur.

While it is hoped that the favorable trial results for vaccine effectiveness in preventing COVID-19 disease will be followed by high levels of effectiveness in preventing infection, the data to demonstrate this will likely not be available when the first vaccine receives Emergency Use Authorization. More will be learned as time goes on as the trials are expected to continue even after receiving authorization from regulators.



Vaccine distribution

Once a safe and effective vaccine is approved, the next challenge will be to manufacture billions of doses and distribute the vaccine around the world. For some types of vaccine, distribution will rely on cold chain infrastructure.

Most vaccines need to be stored within a narrow temperature range. For vaccines produced using traditional platforms, this might be in the range of 2C (36F) to 8C (46F). However, some of the new mRNA vaccines need to be stored at sub-zero temperatures: Moderna's vaccine needs to be kept at minus 20C (minus 4F) and Pfizer's at minus 70C (minus 94F).[8] The infrastructure – storage equipment, planes, trucks, warehouses, and refrigerators – used to safely distribute and store vaccines at these temperatures is the "cold chain."

Potential failures to control the temperature environment of the vaccine that could lead to its degradation exist at each step of the distribution chain:

- Loading onto trucks at the manufacturing site
- Transporting to an airport and transferring from truck to plane
- Taking flights to another airport and transferring to another truck
- Transporting to a cold storage facility and transferring from truck to warehouse
- Reloading another truck and transporting to the eventual point-of-care facility
- Storing at the point-of-care facility until used to vaccinate a patient

An estimated 25%[8] to 50%[9] of vaccines distributed globally are degraded or wasted each year, in large part because of lack of temperature control. It is reasonable to assume that these percentages could be higher for the new mRNA-type vaccines given the extremely low temperatures that must be maintained.

There are concerns that rural hospitals in the U.S. may not be able to afford the necessary infrastructure for mRNA vaccines, which could make it difficult to provide that type of vaccine to rural communities.[10] DHL (logistics firm) has estimated that around two-thirds of the global population lives in parts of Africa, South America, and Asia that could not be readily supplied with a COVID-19 vaccine due to lack of suitable cold chain logistics capacity.[11]

Early access deals

Despite the issues discussed above, governments around the world are, understandably, keen to secure vaccines, and several early access deals have already been announced. See Table 2.

Table 2: Early Access Deals

Initial Purchase/ Additional Option	U.K. Doses (millions)	U.K. Treatments (millions)	U.S. Doses (millions)	U.S. Treatments (millions)	Canada Doses (millions)	Canada Treatments (millions)	EU Doses (millions)	EU Treatments (millions)
Moderna	5	2.5	100/400	50/200	20	10	80/80 *	80/40
BioNTech/Pfizer	30	15	100/500	50/250	20	10	200/100	100/50
J & J (Janssen)	30/22	30/22	100/300	100/300	38	38	200/200	200/200
Oxford/AstraZeneca	100	100	–	–	20	20	300/100	300/100
Novavax	60	30	100	50	76	38	–	–
Sanofi/GSK	60	30	100/500	50/250	72	36	300	150
CureVac	–	–	–	–	–	–	225/180	112.5
Valneva	60	30	–	–	–	–	–	–
Total	345/367	237.5/259.5	500/2,200	300/1,300	246	152	1,305/1,965	902.5/1,292.5

*Deal expected to be finalized soon

Noting that the population of the U.K. is almost 67 million, only the deal with AstraZeneca is enough to cover the total population. Although if two of either Johnson & Johnson (Janssen), Novavax, or Sanofi/GSK are authorized at the same time, together they would cover around 90% of the U.K. population. Canada's population is approximately 38 million, and so three of its six deals would be enough to cover all (or the majority) of its population. The population of the U.S. stands at approximately 331 million, so if the U.S. can secure the doses under the options attached to its deals, three of its five deals would deliver enough vaccine to cover at least 90% of the population. The population of the EU is approximately 446 million, so if the EU can secure the doses under the options attached to its deals with Johnson & Johnson (Janssen) and AstraZeneca, each would be enough to cover around 90% of its total population.

The fact that there are scenarios where the first authorized vaccine does not cover the total population of a country, on top of the fact that some people are more at risk of being infected with the virus and dying of the disease, means that governments need to decide which population subgroups should receive the vaccine first in the hope that at-risk groups are protected as soon as possible.

Roll-out strategies

Some groups of people are at greater risk of contracting COVID-19 and of experiencing more negative disease outcomes if they do contract it. The most important risk factor of serious illness and death is age. Potential vaccination roll-out strategies have been developed for the U.K. and the U.S. based on trying to protect at-risk groups as quickly as possible. The National Advisory Committee on Immunization in Canada has published its recommendations for key population groups to be considered, but has stated it cannot determine a sequential approach (i.e., a priority order) until vaccine characteristics, results of clinical trials, and the number of available doses are known. In the U.K., the Joint Committee on Vaccination and Immunisation has published interim advice on priority groups for receiving a COVID-19 vaccine.[12] The number of individuals in each priority group can be estimated. See Table 3.

Table 3: Estimation of U.K. COVID-19 Vaccine Priority Group Numbers

Priority	Description	Estimated Population (millions)	Cumulative Population (millions)
1	Care home residents and workers	0.4	0.4
2	80+ and health/social care workers	6.0	6.4
3	All those 75+	2.2	8.6
4	All those 70+	3.3	11.9
5	All those 65+	3.3	15.2
6	High-risk adults under 65	2.7	17.9
7	Moderate-risk adults under 65	5.4	23.4
8	All those 60+	3.1	26.5
9	All those 55+	3.5	30.0
10	All those 50+	3.7	33.6
11	Rest of population	33.2	66.8

In the U.S., the National Academies of Sciences, Engineering, and Medicine has published a framework for the equitable allocation of a COVID-19 vaccine.[13] Similarly, the number of individuals in each priority group can be estimated. See Table 4.

Table 4: Estimation of U.S. COVID-19 Vaccine Priority Group Numbers

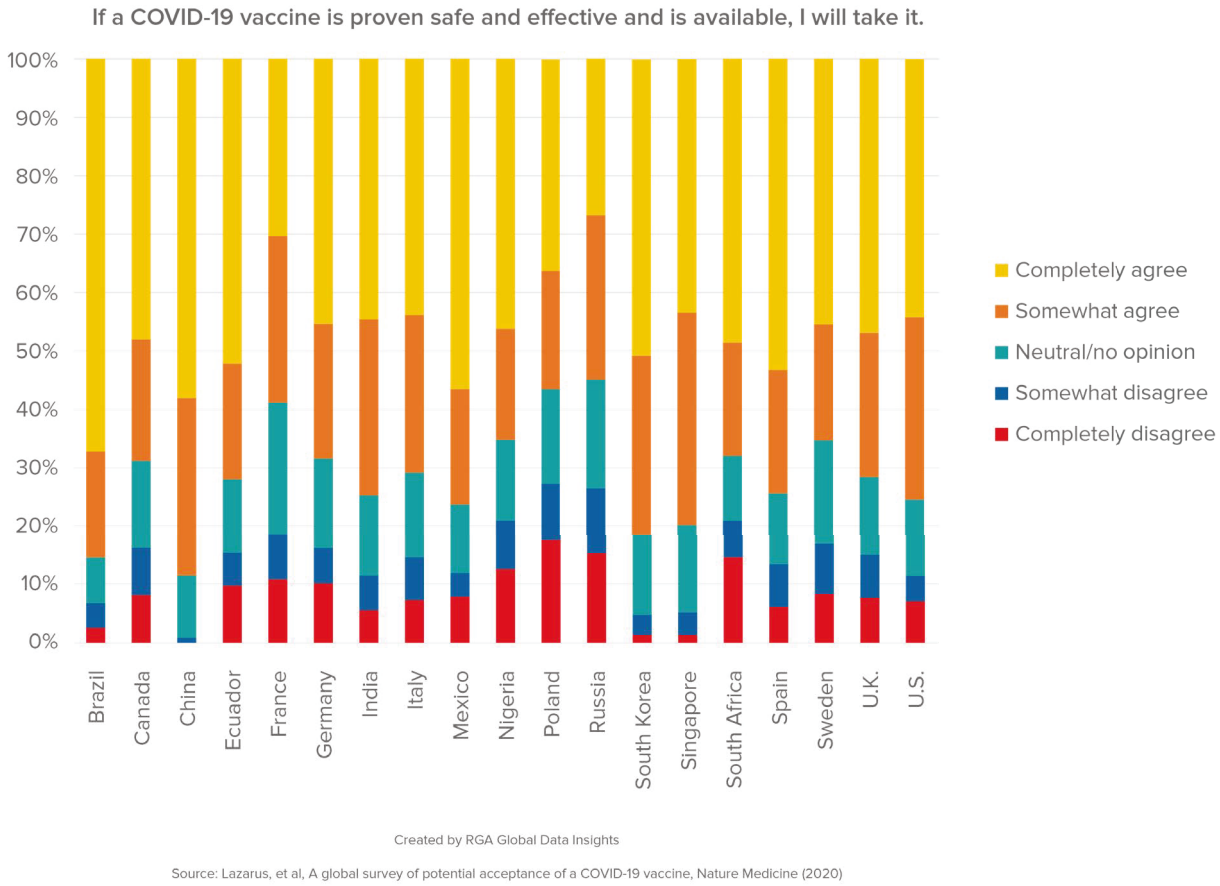
Phase	Description	Approximate Population (millions)	Cumulative Population (millions)
1a	High-risk health workers	16.2	16.2
1a	First responders	2.1	18.3
1b	All ages at high risk	20.0	23.8
1b	Older adults congregate/overcrowded	17.2	55.5
2	K-12 teachers, staff, childcare workers	9.1	64.6
2	Critical workers in high-risk settings	2.7	67.3
2	Moderate comorbid conditions	40.0	107.3
2	Homeless shelters	1.0	108.3
2	Incarcerated people and staff	2.7	111.1
2	All older adults	13.2	124.3
3	Younger adults	46.5	170.8
3	Children	82.1	252.8
3	Workers in important industries	27.5	280.3
4	Everyone else	50.7	331.0

Based on these estimates, if the Pfizer/BioNTech vaccine were the first to be authorized, the U.K. has pre-purchased enough vaccine to treat everyone in priority groups 1 to 5: those over the age of 65 as well as healthcare workers and those who live or work in care homes. Meanwhile, the U.S. has purchased enough vaccine to treat around 90% of the population, covering everyone in phases 1-3 and a proportion of “everyone else” in phase 4. However, even if a safe and effective vaccine were available, it is unlikely that everyone offered the vaccine by their government would take it.

Would you take a safe and effective COVID-19 vaccine?

This question was put to around 13,400 survey participants across 19 countries, and the results recently published in *Nature Medicine*.[14] See Figure 1.

Figure 1: COVID-19 Vaccine Uptake Survey Results



Created by RGA Global Data Insights

Source: Lazarus, et al, A global survey of potential acceptance of a COVID-19 vaccine, Nature Medicine (2020)

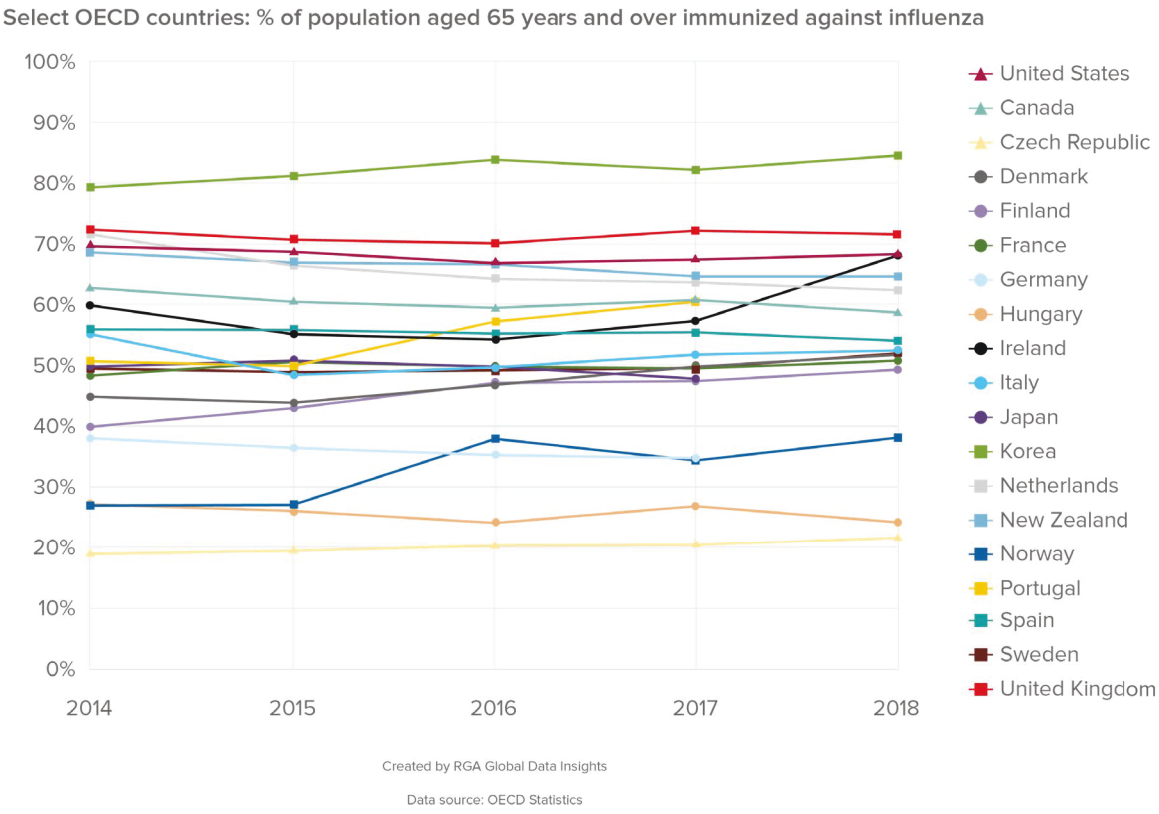
The chart indicates that in many countries approximately 20-40% of respondents say they may not take a COVID-19 vaccine once it first becomes available.

These results are supported by other surveys, including:

- A survey by Gallup, which found that, as of late October, only 58% of Americans would be willing to be vaccinated against COVID-19[15]
- A survey by Pew Research Center that found 51% of U.S. adults said they would definitely or probably get a vaccine to prevent COVID-19 if it were available today[16]
- A survey of over 70,000 people in the U.K. carried out by University College London (UCL) that found 22% would be unlikely to get a COVID-19 vaccine when one is approved[17]

This should not come as a surprise since it reflects similar attitudes expressed in relation to the annual flu vaccine. Influenza is a seasonal virus that in a bad winter can kill tens of thousands of people, yet observed vaccination rates in people over 65 years of age in many Organisation for Economic Co-operation and Development (OECD) countries are only in the 40-70% range. See Figure 2.

Figure 2: Select OECD Countries' Seasonal Influenza Vaccine Uptake Rates – aged 65 years and over



"What if...?" scenarios

Vaccine data can be pulled together to generate "What if...?" scenarios for who might be vaccinated and the level of vaccine-induced immunity that might be achieved by the end of 2021.

The following are illustrations only and not predictions. As Canada has not yet finalized its roll-out strategy, similar priority groupings as the U.K. strategy have been assumed.

Scenario A, shown in Figures 3, 4, and 5, is based on the following assumptions:

- 40% vaccine degradation during deployment for mRNA vaccines
- 20% vaccine degradation during deployment for other vaccines
- 80% vaccine take-up rate
- 40% vaccine effectiveness in preventing transmission
- 60% of additional doses under any options secured in 2021

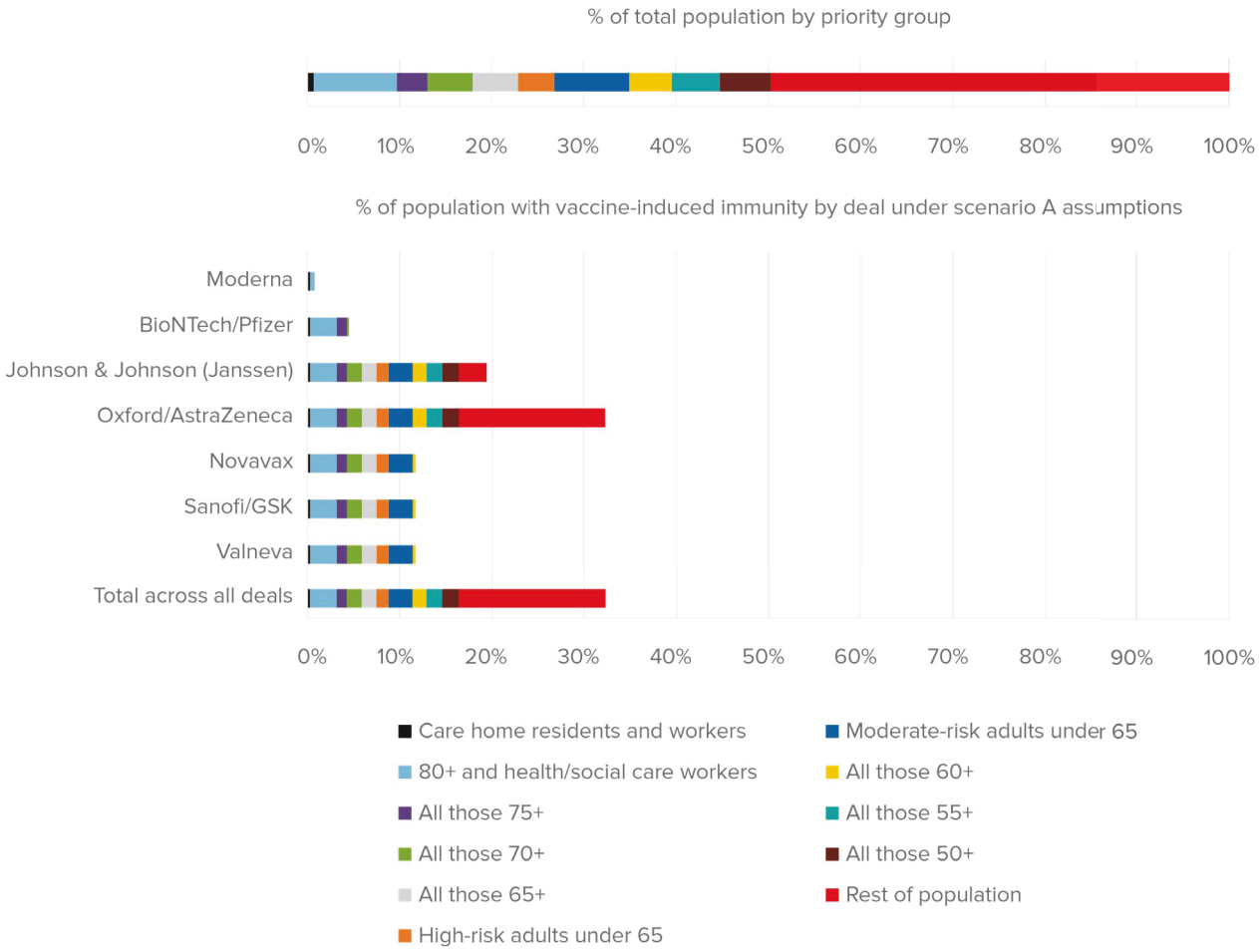
The vaccine take-up rate and effectiveness assumptions determine the maximum vaccine-induced immunity that is possible under the Scenario A:

- If there are enough doses of vaccine to cover the entire population; and
- If 80% of the population takes the vaccine; and
- If 40% of those who take the vaccine develop immunity
- Then 32% (80% x 40%) of the population will have vaccine-induced immunity.

If we assume the take-up rate and effectiveness assumptions apply within each priority group, 32% is also the maximum vaccine-induced immunity that is possible within each priority group in Scenario A. Although, there may be strategies to specifically encourage and target high-risk groups for vaccination, thus impacting these assumptions.

The degradation assumptions, and the assumption for the percentage of doses under any options that can be secured, work to potentially reduce the number of vaccines that are available under each deal in this illustration.

Figure 3: U.K. Vaccine-Induced Immunity by Deal and Priority Group, Scenario A

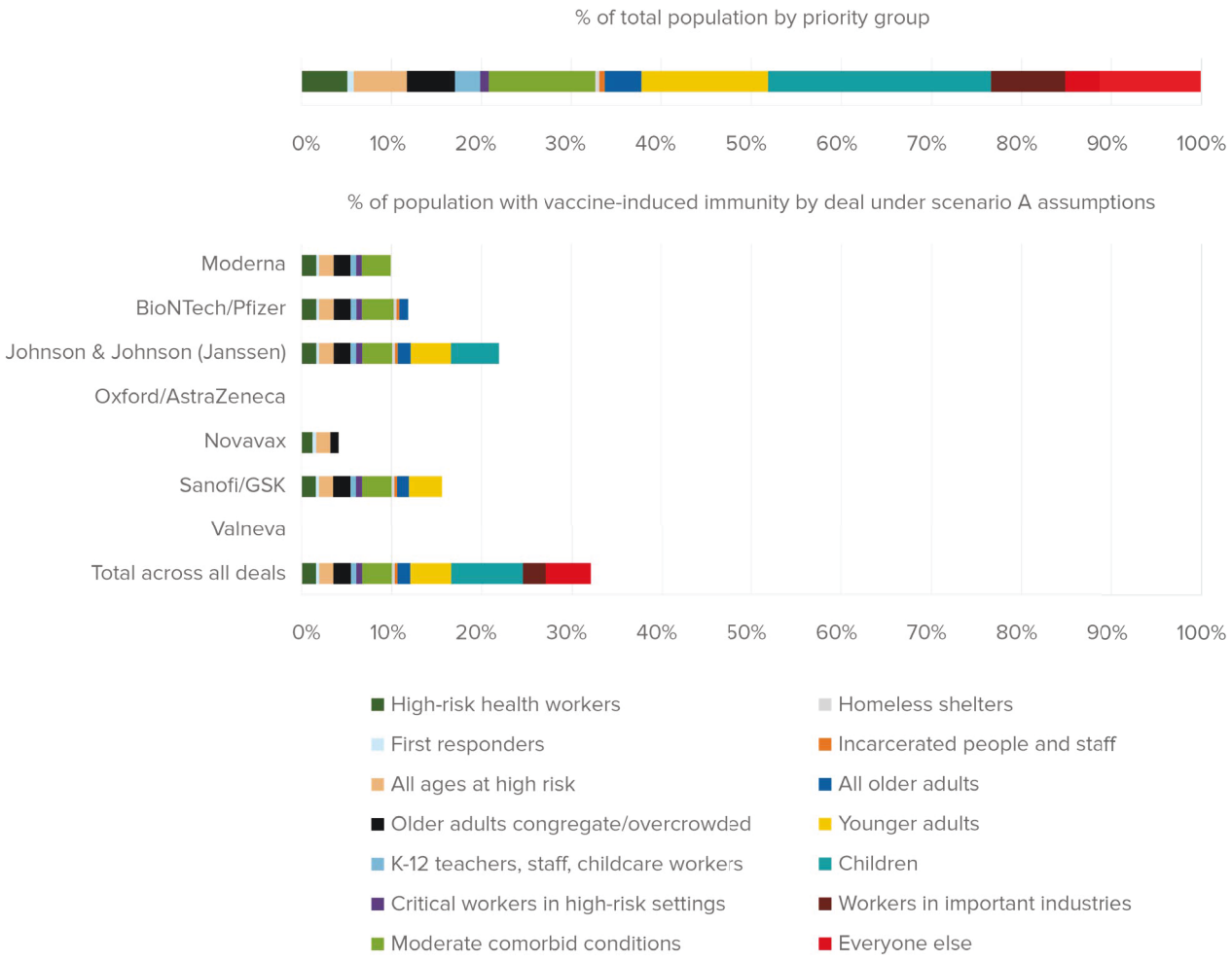


To understand this chart (see Figure 3) consider the U.K.'s deals with Oxford/AstraZeneca and BioNTech/Pfizer. The deal with Oxford/AstraZeneca provides enough vaccine doses, even after assuming 20% degrade during deployment, to cover the whole of the U.K. population. Therefore, under this illustration, the vaccine-induced immunity achieved is 32% of the total population (with 32% immunity in each priority group). Note that as 32% is the maximum vaccine-induced immunity that can be achieved under the assumptions of Scenario A, the same immunity level is achieved when considering either the Oxford/AstraZeneca deal in isolation or the total of all vaccines doses available across all deals. The deal with BioNTech/Pfizer provides 30 million vaccine doses, enough for 15 million treatments in total. Allowing for 40% of these to degrade (since it is an mRNA vaccine) during deployment leaves only 9 million treatments available for use, which is enough to cover around 13% of the U.K. population. The vaccine would therefore be offered to everyone in priority groups 1-3, plus a small proportion of those in priority group 4 (see Table 3). If 80% of those offered the vaccine take it up, and 40% of those who take the vaccine develop immunity, then only around 4% (i.e., 13% x 80% x 40%) of the total population would develop immunity in Scenario A. Within the priority groups,

immunity would be at 32% for priority groups 1-3, around 4% in priority group 4 (since only a small proportion of those in priority group 4 are offered the vaccine), and zero in the other priority groups.

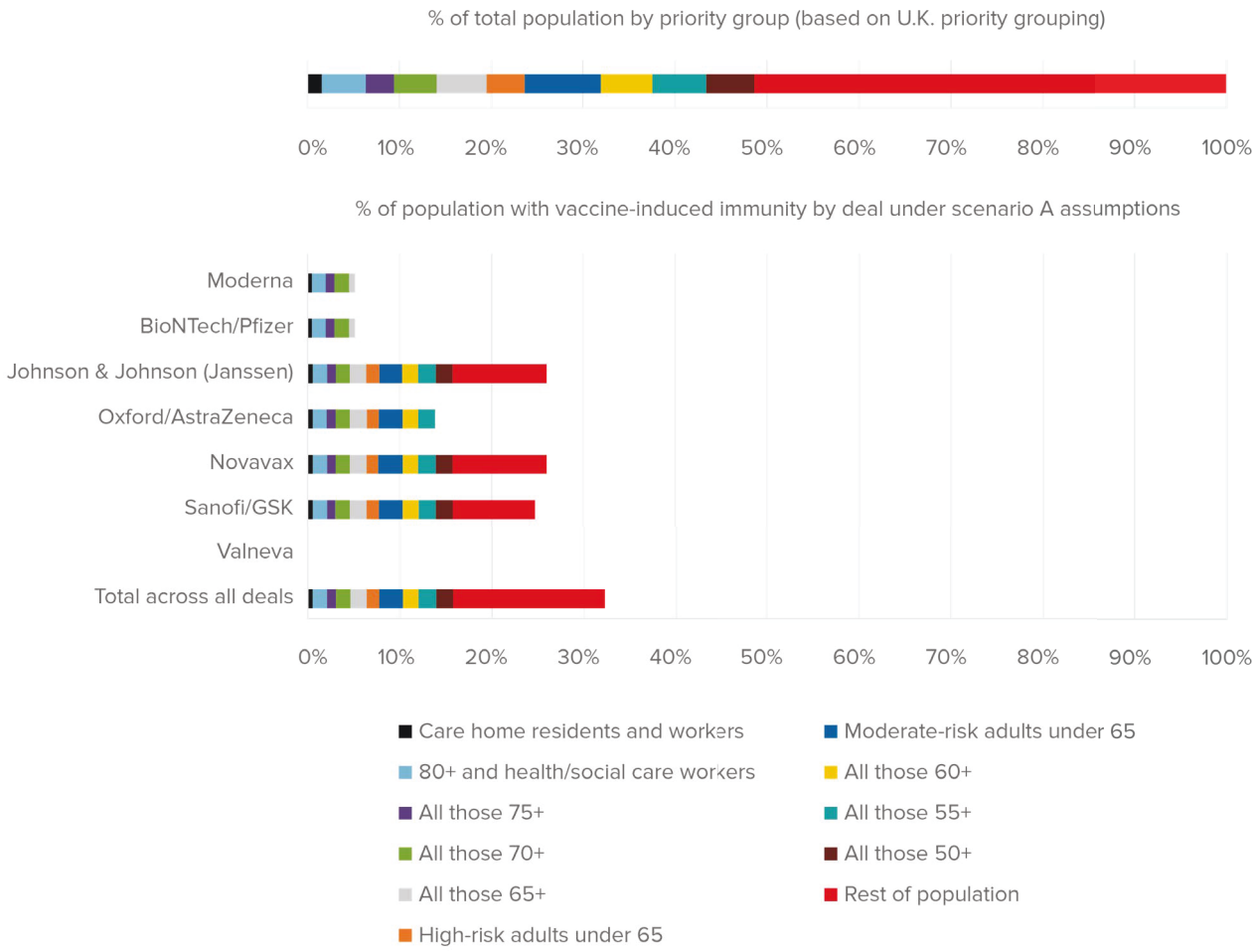
Most of the vaccine doses the U.S. has secured are available through the options attached to four of its deals. The exact details of these options remain unknown – although at least the BioNTech/Pfizer option appears to be on new terms[18] – so with global demand far outstripping supply, it may not be possible for the U.S. to exercise these options at 100% in 2021. In Scenario A we assume the U.S. is able to secure 60% of the vaccine doses under these options. See Figure 4.

Figure 4: U.S. Vaccine-Induced Immunity by Deal and Priority Group, Scenario A



Under Scenario A (see Figure 4), none of the deals provides enough vaccine to treat the entire population once allowance is made for vaccine degradation and the assumption that only 60% of the doses available under options are secured. Therefore, no individual deal achieves the maximum vaccine-induced immunity of 32%. However, if it is assumed that multiple vaccines will be authorized, various combinations would deliver enough vaccine to treat the entire population, resulting in 32% vaccine-induced immunity.

Figure 5: Canada Vaccine-Induced Immunity by Deal and Priority Group, Scenario A



As in the U.S., none of the individual deals Canada has made provides enough vaccine to treat the entire population under the assumptions of Scenario A. Although if it is assumed that multiple vaccines will be authorized, various combinations would deliver enough vaccine to treat the entire population, resulting in 32% vaccine-induced immunity.

Scenario A (see Figures 3, 4, and 5) shows a relatively low level of vaccine-induced immunity achieved through each individual vaccine by the end of 2021, and even if multiple vaccines are authorized, the maximum immunity achieved is 32% of the population. The key driver behind this is the assumption that the vaccine is only 40% effective in reducing transmission.

As an alternative, Scenario B (see Figures 6, 7, 8) considers the following more optimistic assumptions, resulting in a maximum vaccine-induced immunity of 63%:

- 20% vaccine degradation during deployment for mRNA vaccines
- 10% vaccine degradation during deployment for other vaccines
- 90% vaccine take-up rate
- 70% vaccine effectiveness in preventing transmission
- 90% of additional doses under any options are secured in 2021

Figure 6: U.K. Vaccine-Induced Immunity by Deal and Priority Group, Scenario B

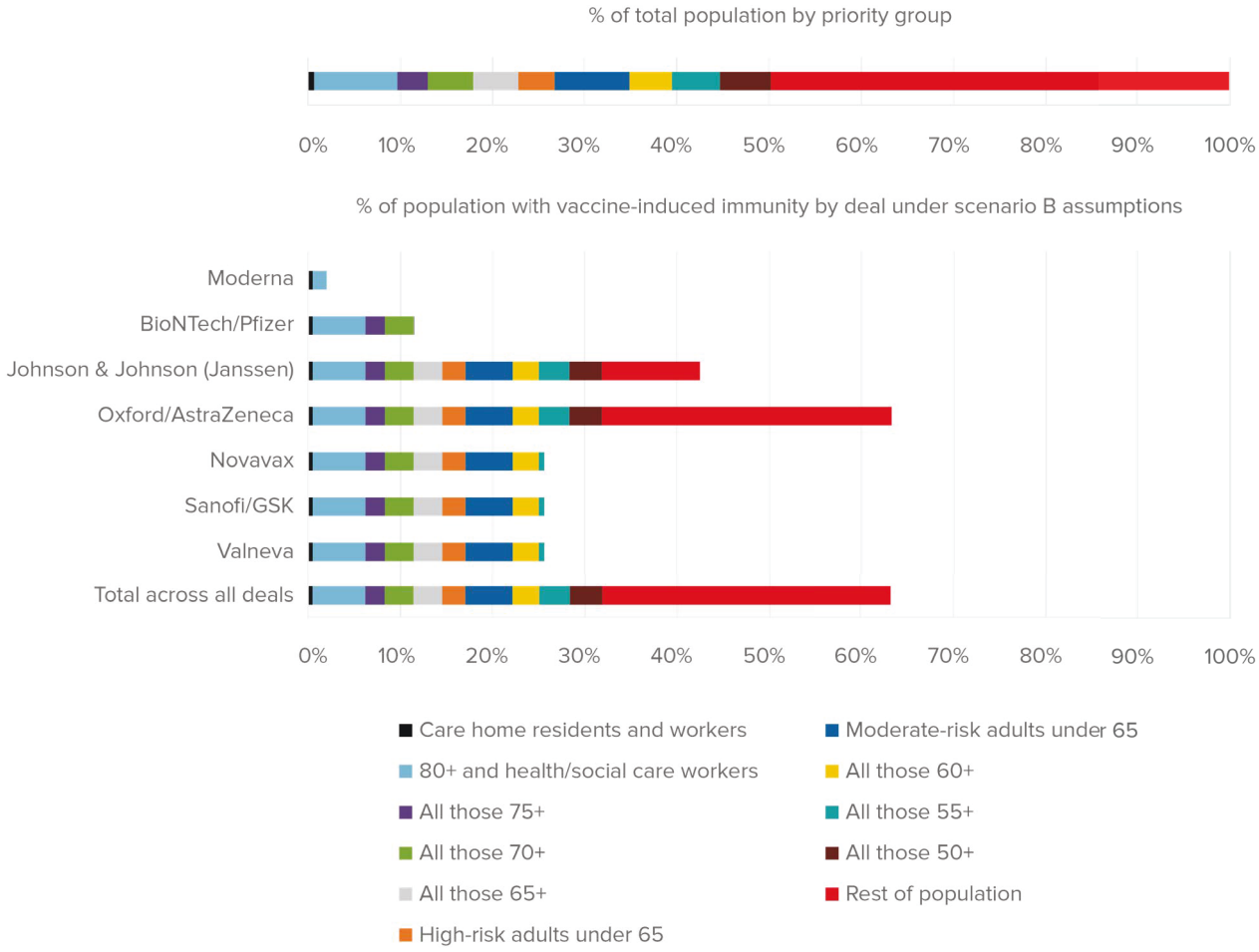
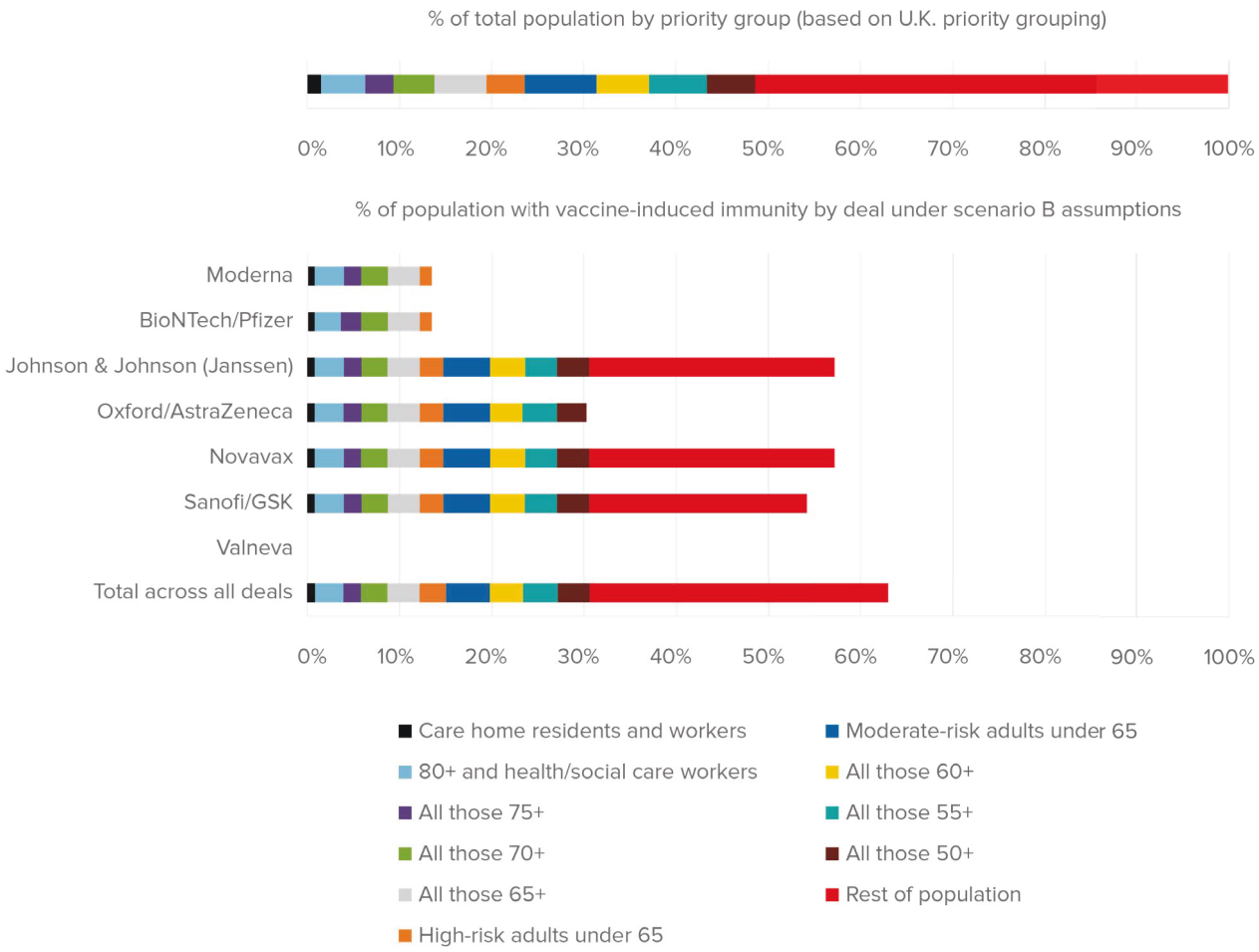


Figure 7: U.S. Vaccine-Induced Immunity by Deal and Priority Group, Scenario B



Figure 8: Canada Vaccine-Induced Immunity by Deal and Priority Group, Scenario B



By considering alternative scenarios, it can be seen that reaching a herd immunity threshold in 2021 – assuming this threshold is around 60-70% – likely requires vaccine take-up rates higher than generally seen for seasonal influenza, vaccine effectiveness in preventing transmission around 70% (or better), and either multiple vaccines authorized or vaccine manufacturing capacity increased.

Vaccine manufacturing capacity

Total annual vaccine manufacturing capacity worldwide is limited. Most immunizations are given to children according to a prescribed schedule.[19] The influenza vaccine is the only vaccine provided annually and is offered to both children and adults. It has been estimated that maximum annual production capacity for the influenza vaccine is around 6.4 billion doses.[20] Achieving estimated levels of COVID-19 herd immunity among the global population using a two-dose vaccine will require approximately twice the world's current manufacturing capacity for influenza vaccine.[21]

In order to increase the proportion of the population that can be vaccinated against COVID-19 by the end of 2021, additional vaccine manufacturing capacity is needed. The infrastructure required differs depending on the type of vaccine to be produced[22] – such as mRNA, viral vectors, protein subunits, or inactivated viruses.

In the U.K., additional capacity to produce non-replicating viral vectors and live attenuated viral vaccines[23] could be provided by the Vaccine Manufacturing and Innovation Centre (VMIC), which is expected to open in summer 2021.[24] It is expected to be able to produce 70 million vaccine doses four to six months from opening.[25]

In the U.S., the Center for American Progress has set out a plan aimed at ensuring efficient manufacturing and distribution of a COVID-19 vaccine.[26] They note that it is too late for the U.S. to build new facilities for increasing vaccine production in 2021 – it would take at least three years to build such infrastructure – but recommend retrofitting four existing facilities to produce 50 million doses each. The U.S. Department of Health and Human Services has, through Operation Warp Speed, made investments in manufacturing capacity,[27] but does not provide estimates of how much additional vaccine capacity these investments have secured.

Other potential issues

Many other potential issues need to be resolved, including:

- Duration of protection provided by the vaccine
- Potential interactions between successive and different COVID-19 vaccines
- Understanding whether current vaccines are safe for children and pregnant women
- Global demand far outstripping limited supply
- Increasing the capacity of vaccination delivery services

As noted earlier, it is unknown if the vaccine protects from infection, and thereby onward transmission, or if it only protects against symptomatic disease. If the vaccine does work to reduce onward transmission, it is unknown how long this protection will last. Answering this question will require monitoring infection rates in vaccinated groups for many months to come.

While the trial results announced by Pfizer/BioNTech, Moderna, and AstraZeneca/Oxford (for one dosing regimen) indicate their vaccines are at least 90% effective at reducing the rate of symptomatic COVID-19 cases, their effectiveness at reducing infection and, hence, onward transmission is not known. It may be the case that the first vaccine authorized is not the most effective in this regard, and a succession of COVID-19 vaccines may be needed, each incrementally more effective than the last. There may be unintended interactions by following this approach – for example, if successive vaccines were based on using an adenovirus as a vector, it is possible that immunity may be developed against the adenovirus, reducing the effectiveness of those later vaccines.

The participants in almost all Phase III trials are age 18 or older, although Pfizer has recently received approval to enroll children as young as 12 years of age in its trial.[28] This means that the first authorized vaccine will not be made available to children. Further trials will be necessary to establish vaccine safety and efficacy in those under age 18.

Pregnant women have not been enrolled in any of the vaccine trials,[29] although several manufacturers have indicated an interest in starting trials involving pregnant women in early 2021.[30] Until such trials are conducted, the necessary safety and efficacy data will not be available to make a COVID-19 vaccine available to pregnant women.

While this paper has focused on the U.S., U.K., and Canada, as soon as the first vaccine is authorized, every country will seek to obtain it at the same time, and global demand will far outstrip the limited supply that will be available in 2021. Concerns have been raised that ”vaccine nationalism” will disadvantage many poorer parts of the world.[31] To address this, the World Health Organization and other international organizations have set up the COVID-19 Vaccines Global Access (COVAX) Facility to work toward equitable global access to COVID-19 vaccines.[32]

Widespread inoculation of almost the entire population of a country will require a significant increase in the services and infrastructure required to deliver those vaccines, including a skilled workforce, appropriate vaccination sites, necessary equipment such as syringes and personal protective equipment, and the integrated IT systems to manage the process and “call and recall” people for their two-dose vaccines.

Summary and implications for life (re)insurers

The issues discussed in this article have some key implications for life (re)insurers as they assess the potential impact of the pandemic.

Reaching a herd immunity threshold in 2021 – assuming this threshold is around 60-70% – likely requires vaccine take-up rates higher than generally seen for seasonal influenza, vaccine effectiveness at preventing transmission around 70% (or better), and either multiple vaccines authorized or vaccine manufacturing capacity increased. None of these is guaranteed, but a significant portion of the population will likely be vaccinated throughout 2021. Even if herd immunity is not achieved in 2021, it appears that vaccines have the potential to be very effective at reducing severe COVID-19 disease, which would significantly reduce mortality risk. However, given the uncertainty around how long vaccine-induced immunity might last, life (re)insurers should be prepared for the possibility of ongoing COVID-19 mortality risk to some degree in 2022 and beyond. As the vaccine is rolled out across different priority groups in 2021, the profile of those exposed to risk of infection and severe disease will change and will need to be reflected in forward-looking assumptions for infections and infection fatality rates. ■

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