

Commentary

Achieving path-dependent equity for global COVID-19 vaccine allocation

Anthony D. So^{1,2,*} and Joshua Woo^{1,2}

Committing to global access for COVID-19 vaccines is key to avoiding a resurgence of the pandemic. However, agreements between countries and vaccine manufacturers have undermined a globally coordinated approach, and the ongoing vaccine rollout highlights long-standing inequities in health. Yet, the surest path out of this pandemic is one toward greater equity.

In a globalizing world, pathogens cross borders readily, as do the expectations of life-saving vaccines, but the products often lag behind. This asymmetry in globalization gives rise to health inequity. Delays in life-saving treatments arriving in low- and middle-income countries (LMICs) years after they have become available in high-income countries is not new, but COVID-19 has shone a spotlight on this.

In fact, the delay between first approval in a high-income country and final approval in Sub-Saharan Africa for products preventing or treating communicable diseases has historically added 4 to 7 years.¹ To bring such products from bench to bedside, product development partnerships and financing mechanisms like advanced market commitments have helped to speed or scale their development; collaborative procedures for accelerated registration have expedited their approval in countries that can take advantage of work already carried out by stringent drug regulatory authorities; and agencies like United Nations International Children's Emergency Fund (UNICEF) have worked to procure and scale these products. The key difference now is that there is urgency in delivering COVID-19 vaccines not only to LMICs, but also to the entire globe—both to address humanitarian needs and also to stamp out the risk

of pandemic resurgence and of variants emerging.

Just as it has highlighted disparities within countries, COVID-19 has exposed the gulf between countries as well. Before the first vaccine received US FDA Emergency Use Authorization, just over half of pre-market purchase commitments of COVID-19 vaccines were reserved by high-income countries comprising 14% of the world's population.² Canada, Australia, the United Kingdom, Japan, the European Union, and United States all had reserved more than one vaccine course per person for their respective populations. However, financing for the COVAX Facility—the vaccines pillar of the World Health Organization (WHO)'s Access to COVID-19 Tools (ACT) Accelerator—was still coming together then, and 40% of the projected capacity for vaccine production by the end of 2021 among leading manufacturers had not been bought up by that time.² Hedging their bets, countries arguably were responsibly diversifying their risks by investing across a range of candidate vaccines, because no one knew which would eventually succeed.

As vaccines are now administered, this disparity has only widened, and the rift in global solidarity has become glaringly obvious. Opening the WHO's Executive Board in January, Director-

General Tedros Adhanom Ghebreyesus related, "More than 39 million doses of vaccine have now been administered in at least 49 higher-income countries. Just 25 doses have been given in one lowest-income country. Not 25 million; not 25,000; just 25."³ After three months of COVID-19 vaccine distribution, the United States and China account for nearly half of all vaccinations globally, and nearly 60% of all vaccines have been administered in high-income countries (see [Table S1](#)).

The WHO put forward an approach to equitable allocation based on ensuring COVID-19 vaccine doses proportional to population, prioritizing high-risk individuals and vulnerable populations first within recipient countries.⁴ With over fifty countries not having administered any COVID-19 vaccines, the world seems far from meeting the global demand (<https://covid19.who.int/>). However, efforts are stepping up. Boosted by recent pledges from G7 countries, the COVAX Facility has mobilized US\$6.3 billion for 92 lower-income countries eligible to receive donor-funded doses of COVID-19 vaccines (<https://www.gavi.org/news/media-room/g7-backs-gavis-covax-amc-boost-covid-19-vaccines-worlds-poorest-countries>). Belatedly, the United States, under a new administration, has joined COVAX—pledging US\$4 billion of this total. To date, COVAX has secured over a billion doses and, in the first two quarters of this year, will roll out about 240 million doses, 12% of its end-of-year goal of 2 billion doses (see [Table S2](#)). Still these

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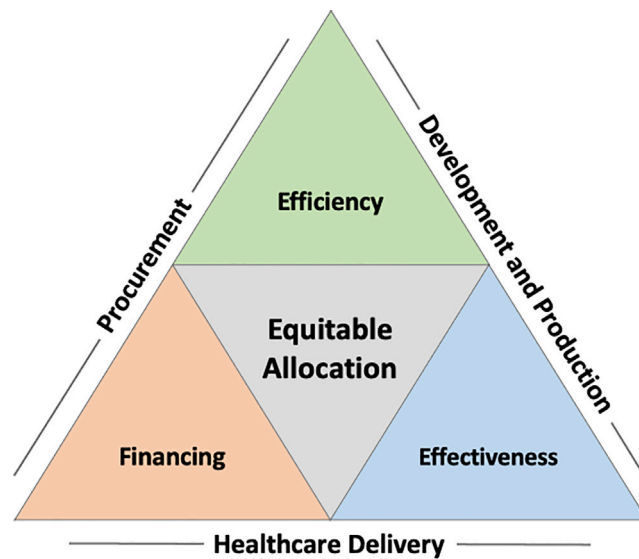


Figure 1. Triangle of equitable allocation for COVID-19 vaccines

efforts will leave most lower-income countries considerably short of achieving herd immunity through vaccination.

No country's government can be faulted for wanting to take every domestic measure possible to avoid further tragedy. A year into this pandemic, the United States has lost over half a million lives—more than the country's lives lost in World War I, World War II, and the Vietnam War combined and a fifth of the world's total toll. However, the boomerang risk of continued transmission and emerging variants should motivate a global response in ways that diseases like HIV/AIDS, malaria, and tuberculosis have not in the past. With only vaccination of those susceptible in advanced economies, the economic toll may mount to trillions more, much of it falling back on these high-income countries.⁵ The surest path out of this pandemic is also the one toward greater equity. Admittedly though, the decisions made by countries to date, the bilateral deals struck, and the lack of global solidarity make this road to equity path dependent.

In bringing COVID-19 vaccines to market, equitable allocation is a function of demonstrating vaccine candidate

effectiveness, ensuring financing for healthcare systems, and enabling efficient delivery. As these vaccines become available, three policy levers might help define the triangle of equitable allocation (see [Figure 1](#)): development and production, procurement, and ultimately, healthcare delivery. Development and production shape the supply side; healthcare delivery, the demand side; and procurement, demand against available supply. How do we triangulate these factors to achieve more equitable allocation of COVID-19 vaccines?

Development and production

Development and production of COVID-19 vaccines for global allocation will necessarily unfold in stages. Sustaining the research & development (R&D) pipeline will be important for several reasons. Among the 81 COVID-19 vaccines currently in clinical development, other vaccines may yet come forward, offering just-in-time alternatives tested on variants, options better suited for delivery in resource-limited settings, or longer lasting duration of immunity.⁶ This progress will continue to rely on timely sharing and exchange of data, biospecimens, and research findings. Regulatory review filings and peer-reviewed journal publications have provided much needed trans-

parency over the science behind claims of vaccine efficacy.

Such transparency has provided reassurance to policymakers and the public that vaccine candidates work across a range of ages and diverse populations, protect against severe disease, and have acceptable risk profiles. However, the duration of immunity and effectiveness against variants remain in continuing flux. Already, drops in efficacy have been observed in clinical trials carried out in South Africa—where the B.1.351 variant predominates—for AstraZeneca/Oxford, Novavax, and Johnson & Johnson/Janssen candidates.⁷ Without ramped up diagnostic testing for COVID-19 variants, comparing vaccines tested in different countries will become harder, limiting where we might generalize the findings of clinical trials.

In the near term, a key bottleneck to ensuring global access to these vaccines is production. No single vaccine manufacturer is positioned to produce enough vaccines for global coverage. To meet global demand, multiple vaccines will have to be scaled, each with a network of partners. The need for investing in these production facilities was anticipated early on. The Coalition for Epidemic Preparedness Innovations (CEPI) had made strategic investments in a global manufacturing network, both reserving capacity for production of the active ingredient for COVID-19 vaccines and securing supplies of glass vials (https://cepi.net/news_cepi/cepi-expands-global-manufacturing-network-reserving-manufacturing-capacity-for-more-than-1-billion-doses-of-covid-19-vaccines/). UNICEF announced plans last October to stockpile over half a billion syringes by the end of 2020.⁸ The COVAX Facility brought together key partners, from the WHO and CEPI to UNICEF and the Pan American Health Organization's (PAHO's) Revolving Fund for Vaccine Access.

Still, these efforts collectively fall significantly short of the capacity needed to

meet global demand. Speeding the pace of scale-up will require enlisting more partners. This will entail sharing intellectual property and the technical know-how of manufacturing these vaccines. Some have called for voluntary pledges to share such intellectual property;⁹ others, both from governments led by South Africa and India and from civil society groups led by voices from the People's Vaccine Alliance, for a Trade-Related Aspects of Intellectual Property Rights (TRIPS) waiver suspending patent rights on COVID-19-related technologies to meet the urgent needs during the pandemic. Forty member states joined Costa Rica in calling on WHO to establish a COVID-19 Technology Access Pool (C-TAP) that would facilitate the voluntary sharing of knowledge, data, and intellectual property needed to accelerate the development of products to address COVID-19.

The sharing of intellectual property has already proven critical for several of the leading COVID-19 vaccines that target the coronavirus spike glycoprotein, which aids the viral membrane to fuse with the human host cell. The antibody response of these COVID-19 vaccines to this target depends on stabilizing the spike protein in its prefusion conformation, and this relies on an approach developed and patented by NIH and academic scientists. Reportedly, at least three mRNA vaccines (Pfizer/BioNTech, Moderna, and CureVac) as well as the vaccine candidates developed by Johnson & Johnson and Novavax rely on this publicly funded, patented invention (https://www.citizen.org/article/leading-covid-19-vaccines-depend-on-nih-technology/?eType=EmailBlastContent&eld=3dbde9f7-8f59-48e0-99d8-78b49ea5e77e#_ftn3). Just as these first-generation vaccines have depended on the ability to license a key patented invention to accelerate their product development, so may be the case for second-generation vaccines, of which there are over 260 candidates in the pipeline.⁶ Over 30 of these vaccines are based on the mRNA vaccine

platform. Yet, a patent landscape of the mRNA vaccine space found the intellectual property holdings to be “highly fragmented,” with BioNTech, Moderna, CureVac, and GSK collectively owning half of these patent applications.¹⁰ A proposal such as C-TAP was meant to anticipate the challenge of a potential patent thicket, but to date, not one vaccine firm has licensed patents voluntarily as part of this initiative. Such a technology trust can provide needed public-sector stewardship for the building blocks of knowledge that must be widely licensed, so that the development of products to fight COVID-19 can be accelerated from bench to bedside and affordably distributed to those in need.

Public investment will also be needed to facilitate technology transfer, contract existing manufacturing facilities, and build new facilities to scale up vaccines for the current and future pandemics. A key motivation for making this investment should be to ensure the capacity to switch vaccines. With potentially new COVID-19 variants on the way, lead vaccine manufacturers may not be well positioned to switch to a demonstrably better vaccine, even if their facilities could scale its production. Public investment and control over the manufacturing infrastructure of the supply chain could speed the switch to such a better, second-generation vaccine.

Procurement

Public sector procurement provides assurances to manufacturers of market demand and leverages monopsony buying power to ensure affordable pricing. Effective procurement requires many key elements, but we will focus here on transparency of COVID-19 vaccine arrangements, global coordination of vaccination efforts, an effective sharing and exchange mechanism for COVID-19 vaccine doses, and affordable pricing.

At every stage, from R&D to delivery, there needs to be transparency of the COVID-19 supply chain. Making clinical trial findings available builds public confi-

dence in vaccine performance and in the government's process to ensure effectiveness and safety of these products. Vaccine manufacturers should be keen for this review, for it reflects a partnership and a shared responsibility to bring forward new vaccines should unforeseeable adverse reactions, logistical challenges in delivery, or disinformation efforts require response. Transparency should also extend to the public financing of these vaccines as well as the pricing, licensing, purchase commitments, and scale-up options. Unless vaccine manufacturers can shoulder the responsibility and the public accountability for deciding which country's vaccine orders come first and which countries come last, transparency is a prerequisite to global coordination of vaccination efforts. It should not be the prerogative of any private company to ration a pandemic vaccine for the world. So, country governments, beginning with those home to these vaccine manufacturers, should insist on such transparency and work to make signed vaccine deals transparent.

While the vaccine doses may not yet be in hand, all of the G7 countries—including Canada, Japan, the United States, the United Kingdom, and France, Italy, and Germany as part of the European Union—have secured sufficient approved COVID-19 vaccines to cover their entire populations (see [Table S3](#)). The French government has proposed sharing 5% of its vaccine doses, and the United Kingdom and Germany have indicated a willingness to provide surplus vaccines to COVAX, with timing and quantity to be determined. The critical question is at what level of domestic vaccination efforts are national governments prepared to share available vaccine supplies with other countries. While there remains uncertainty around the duration of immunity and effectiveness against emerging variants, now is the time to make clear, public, and principled commitments to share any surplus and to help mobilize the manufacturing capacity to make up the difference.

The patchwork of bilateral deals has complicated efforts to roll out COVID-19 vaccines. The COVAX Facility recently published their interim distribution forecast of COVID-19 vaccines, based on projected availability of two vaccine candidates approved by the WHO for emergency use: AstraZeneca/Oxford and Pfizer/BioNTech (<https://www.who.int/news/item/03-02-2021-covax-publishes-first-interim-distribution-forecast>). Out of the 140 UN member states included in this distribution, more than 40 countries had also signed bilateral purchase commitments for vaccine doses in addition to those received through the COVAX Facility (see [Table S4](#)). Earlier bilateral purchase commitments had been struck largely by high-income countries, but now many middle-income countries have such arrangements as well. Could some countries be double-dipping, drawing on their COVAX allocation while also receiving doses under bilateral purchase commitments?

Sharing and exchange mechanisms are impeded by limits on the interchangeability of vaccines, on where countries are in the queue for receiving vaccines, and on export restrictions. Not all COVID-19 vaccines are shareable from one country to another, given differences in cold-chain requirements, effectiveness against variants, and other factors. With multiple vaccines coming onto the market, temporal trading of places in the queue might also speed global access. For example, should the United States, which has not yet approved the AstraZeneca/Oxford vaccine, make a temporal trade on its reserved doses with countries waiting and ready to use this vaccine now (<https://www.nytimes.com/2021/03/11/us/politics/coronavirus-astrazeneca-united-states.html?smid=url-share>)? Export restrictions can also thwart efforts to distribute vaccines. The European Union has required that companies receive authorization before exporting COVID-19 vaccine doses. Facing un-

der-delivery from AstraZeneca/Oxford for vaccines destined to the European Union, Italy blocked more than 250,000 of these vaccine doses to Australia.¹¹ While these export controls were set to expire in March, the European Union plans to extend these measures until at least the end of June.¹²

Regional procurement facilities also have the potential of bolstering such sharing and exchange. While the PAHO Revolving Fund for Vaccine Access has long served Latin America and the Caribbean to secure vaccine doses, another regional platform is emerging and could complement COVAX's efforts. The African Union has established the Africa Vaccine Acquisition Task Team to secure sufficient vaccine doses to achieve a target immunization level of 60% (<https://www.afreximbank.com/african-union-member-states-accelerates-online-pre-orders-as-amp-adds-300-million-sputnik-v-doses-to-its-covid-19-vaccine-portfolio/>). South Africa has switched from the AstraZeneca/Oxford vaccine, which has proven less effective against the B.1.351 variant, to other COVID-19 vaccines, and in so doing, has offered the AstraZeneca/Oxford doses to the African Union for use in countries where this variant is not widely circulating. Building such regional capacity may provide needed infrastructure for addressing COVID-19 vaccine supply and perhaps other health commodities over time.

Given limited financing, low-cost pricing of vaccines will be key to enabling countries to secure sufficient vaccine doses for population coverage. However, vaccine prices vary widely, with mRNA vaccines commanding higher prices compared with most other platforms. Such price differentials can have significant impact on budgets: switching from the AstraZeneca/Oxford vaccine to an mRNA vaccine could result in a nearly 3-fold increase in the financing required.¹³ While several vaccine manufacturers have pledged pandemic pricing, some reportedly at

no profit, the question remains when pandemic pricing will go away.

Many reasons could explain the range of vaccine prices, including differences in the costs of R&D, manufacturing, distribution, licensing arrangements, and level of public financing. In the end, the costs for developing successful vaccines are covered by the public, either upfront through financing that pays for the inputs of R&D or financing that pays for the outputs through purchase of vaccine doses. In 2019, the World Health Assembly adopted a resolution urging member states to, among other things, "take appropriate measures to publicly share information on the net prices of health products" and "work collaboratively to improve the reporting of information by suppliers on registered health products, such as reports on sales revenues, prices, units sold, marketing costs, and subsidies and incentives."¹⁴ Now would be an excellent time for member states to follow through on the WHO's transparency resolution (<http://g2h2.org/wp-content/uploads/2019/12/Session-2-Thiru.pdf>).

Healthcare Delivery

Deployment of vaccines in the healthcare delivery system will present challenges. Lowering R_t (the rate of transmission) below 1 is a goal achievable only if effective herd immunity is reached in the population, population coverage is sufficiently high, and pandemic social distancing measures hold while the other two aims are achieved. High-income countries have shown just how hard this is to achieve even in well-resourced settings. Financing the in-country delivery of vaccines, from cold chain to administration, must also fall into place if last-mile challenges are to be surmounted. As the sprint turns into a marathon, will the financial commitments from multilateral institutions and development banks hold and sustain financing on the road to recovery?

For LMICs, this story of being last in line is not new. In 2009, the emergence of

the H1N1 influenza virus prompted a WHO declaration of a global pandemic and led to efforts to develop a vaccine. After a slow start and shortages, vaccine supply began to scale, but not before patient demand began to wane as it typically does with seasonal influenza.¹⁵ Of 229 million vaccine doses bought by the United States, 91 million were used, 71.5 million were possibly discarded, and only 25 million donated to other countries (<https://web.archive.org/web/20100408172009/http://www.washingtonpost.com/wp-dyn/content/article/2010/03/31/AR2010033104201.html>). This time round, governments around the globe should show global solidarity and commit to do better.

The path into this pandemic has sharply reminded us of long-standing health inequities, only made starker because of its toll on livelihoods as well as lives. When we turn the page on this chapter, perhaps we can do more to ensure that it is remembered for the more equitable path we sought to pave on the way out of this pandemic.

SUPPLEMENTAL INFORMATION

Supplemental information can be found online at <https://doi.org/10.1016/j.medj.2021.03.004>.

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DECLARATION OF INTERESTS

The authors declare no competing interests.

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Supplemental information

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Supplemental File

Table S1. COVID-19 vaccines administered by country and country classifications

Country	Country Classification^{1*}	COVID-19 Vaccine Doses Administered²
United States of America	HIC	82,572,848
China	UMIC	52,520,000
India	LMIC	24,037,644
United Kingdom	HIC	23,773,959
Turkey	UMIC	10,222,994
Israel	HIC	8,731,727
Brazil	UMIC	8,580,097
Germany	HIC	7,681,678
Russian Federation	UMIC	6,694,349
United Arab Emirates	HIC	6,325,211
France	HIC	5,807,779
Italy	HIC	5,407,294
Spain	HIC	4,742,602
Morocco	LMIC	4,613,292
Indonesia	UMIC	4,534,798
Chile	HIC	4,270,024
Bangladesh	LMIC	4,013,963
Poland	HIC	4,006,643
Mexico	UMIC	2,583,435
Canada	HIC	2,225,278
Romania	HIC	1,832,198
Netherlands	HIC	1,619,839
Argentina	UMIC	1,357,596
Hungary	HIC	1,316,935
Nepal	LMIC	1,106,599
Greece	HIC	1,089,250
Portugal	HIC	1,032,968
Belgium	HIC	990,335
Sweden	HIC	985,681
Switzerland	HIC	948,678
Czechia	HIC	834,427
Austria	HIC	830,688
Serbia	UMIC	750,533
Denmark	HIC	742,695
Sri Lanka	LMIC	737,062
Singapore	HIC	611,314
Norway	HIC	584,212
Finland	HIC	575,433
Slovakia	HIC	544,986
Ireland	HIC	530,197
Bahrain	HIC	514,559
Republic of Korea	HIC	446,941
Peru	UMIC	347,241
Qatar	HIC	327,000
Dominican Republic	UMIC	303,490
Saudi Arabia	HIC	295,530
Bulgaria	UMIC	294,133
Lithuania	HIC	292,261
Croatia	HIC	264,703
Pakistan	LMIC	227,917
Slovenia	HIC	207,287
Colombia	UMIC	206,475
Maldives	UMIC	165,675
Panama	HIC	150,411
Costa Rica	UMIC	149,812
Estonia	HIC	146,083
Azerbaijan	UMIC	143,115
Malaysia	UMIC	139,720
South Africa	UMIC	107,054

Myanmar	LMIC	104,865
Jordan	UMIC	101,230
Oman	HIC	98,947
Cyprus	HIC	98,427
Seychelles	HIC	97,779
Australia	HIC	94,908
Malta	HIC	92,771
Latvia	HIC	82,115
Algeria	LMIC	75,000
Lebanon	UMIC	64,974
Iran	MIC	60,486
Uruguay	HIC	54,154
Senegal	LMIC	52,031
Luxembourg	HIC	47,515
Belarus	UMIC	46,645
Japan	HIC	46,469
Cambodia	LMIC	44,918
Barbados	HIC	44,859
Ecuador	UMIC	42,114
Iceland	HIC	41,989
Zimbabwe	LMIC	35,761
Jersey	HIC	33,511
Afghanistan	LIC	31,150
Ukraine	LMIC	29,584
Isle of Man	HIC	26,172
Cayman Islands	HIC	25,408
Kazakhstan	UMIC	22,294
Guernsey	HIC	22,040
Bermuda	HIC	20,705
Bolivia	LMIC	20,025
Thailand	UMIC	17,697
El Salvador	LMIC	16,300
Mongolia	LMIC	15,432
Philippines	LMIC	13,629
Venezuela	UMIC	12,194
Dominica	UMIC	10,476
New Zealand	HIC	9,431
Aruba	HIC	8,882
Faroe Islands	HIC	8,068
Anguilla	HIC	7,700
Palestine	--	6,360
Turks and Caicos Islands	HIC	6,347
Moldova	LMIC	5,390
Greenland	HIC	3,927
Mauritius	HIC	3,843
North Macedonia	UMIC	3,536
Lao People's Democratic Republic	LMIC	3,341
British Virgin Islands	HIC	3,334
Equatorial Guinea	UMIC	3,222
Liechtenstein	HIC	3,126
Grenada	UMIC	3,061
Honduras	LMIC	2,787
Montenegro	UMIC	2,629
Andorra	HIC	2,526
Kuwait	HIC	2,500
Guatemala	UMIC	2,427
Monaco	HIC	2,400
Saint Vincent and the Grenadines	UMIC	2,280
San Marino	HIC	2,251
Iraq	UMIC	2,177
Guyana	UMIC	2,050

Falkland Islands	HIC	1,732
Paraguay	UMIC	1,725
Saint Kitts and Nevis	HIC	1,631
Saint Lucia	UMIC	1,460
Egypt	LMIC	1,315
Trinidad and Tobago	HIC	1,137
Montserrat	HIC	859
Suriname	UMIC	729
Belize	UMIC	673
Albania	UMIC	671
Ivory Coast	LMIC	660
Antigua and Barbuda	HIC	383
Nigeria	LMIC	80
Uganda	LIC	80
Angola	LMIC	1
Curacao	HIC	1
Gambia	LIC	1
Kenya	LMIC	1
Marshall Islands	UMIC	1
Micronesia	LMIC	1
Nicaragua	LMIC	1
Togo	LIC	1
Total Doses Administered	--	298,957,960

*HIC = high-income country; UMIC = upper-middle-income country; LMIC = lower-middle-income country; LIC = low-income country

¹Country classifications based on World Bank 2021 classifications, available at:

<https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.

²Vaccine administration data sourced from the World Health Organization Coronavirus (COVID-19) Dashboard, as of March 11, 2021. Available at: <https://covid19.who.int/>.

**Per cent of COVID-19 vaccines administered to HICs calculated by the formula: $\frac{\text{total doses administered to HICs}}{\text{total doses administered}}$

Table S2. COVAX distribution portfolio for COVID-19 vaccines

	Goal for Total COVID-19 Vaccine Doses by 2021¹	Total COVID-19 Vaccine Doses Procured²	COVID-19 Vaccine Rollout within Q1/Q2 2021³
COVAX Facility	2B doses	Pfizer/BioNTech: 40M AstraZeneca/Oxford: 270M Novavax: 100M J&J/Janssen: 500M Sanofi/GSK: 200M	AstraZeneca and AstraZeneca/SII: 237M Pfizer/BioNTech: 1.2M

¹COVAX goal for COVID-19 vaccine supply by end-of-year 2021 sourced from COVAX briefing document. Available at: <https://www.who.int/news/item/18-12-2020-covax-announces-additional-deals-to-access-promising-covid-19-vaccine-candidates-plans-global-rollout-starting-q1-2021>.

²COVID-19 vaccine reservation data sourced from UNICEF's COVID-19 Vaccine Market Dashboard, as of March 12, 2021. Available at: <https://www.unicef.org/supply/covid-19-vaccine-market-dashboard>.

³COVID-19 anticipated vaccine distribution for Q1/Q2 2021 sourced from COVAX's interim distribution forecast, as of March 2, 2021. Available at: <https://www.gavi.org/sites/default/files/covid/covax/COVAX-First-round-allocation-of-AZ-and-SII.pdf>.

*Per cent of year-end goal met by COVAX calculated by the formula: $\frac{\text{COVID-19 vaccine rollout within Q1/Q2 of 2021}}{\text{Goal for total doses by 2021}}$

Table S3. Approved COVID-19 vaccine doses reserved by G7 countries relative to country population

Country	Country Population¹	Approved COVID-19 Vaccine Courses Reserved²
Canada	37,589,260	90,000,000
European Union	447,512,041	492,500,000
France	126,264,930	--
Germany	83,132,800	15,000,000
Italy	60,297,400	35,000,000
Japan	126,264,930	132,000,000
United Kingdom	66,834,400	78,500,000
United States	328,239,520	400,000,000

¹Country population based on World Bank 2019 population data, available at: <https://data.worldbank.org/indicator/SP.POP.TOTL>.

²COVID-19 vaccine reservation data sourced from UNICEF's COVID-19 Vaccine Market Dashboard, as of March 12. Available at: <https://www.unicef.org/supply/covid-19-vaccine-market-dashboard>.

*France, Germany and Italy are assumed to be covered under the European Union's reserved doses. All doses from vaccine manufacturers that have been granted approval or emergency use authorization are included, but it is not yet known when these vaccines will be fully administered. Janssen's COVID-19 vaccine is calculated as a one-dose vaccine; all others are two-dose vaccines.

Table S4. List of countries that have both signed bilateral purchase commitments and are on the list for COVAX's Q1/Q2 2021 interim distribution forecast*

Count	Country
1	Albania
2	Argentina
3	Bangladesh
4	Bolivia
5	Bosnia and Herzegovina
6	Botswana
7	Brazil
8	Canada
9	Chile
10	Colombia
11	Costa Rica
12	Ivory Coast
13	Dominican Republic
14	Ecuador
15	Egypt
16	India
17	Indonesia
18	Iraq
19	Jordan
20	Lebanon
21	Malaysia
22	Maldives
23	Mexico
24	Morocco
25	Nepal
26	New Zealand
27	North Macedonia
28	Oman
29	Pakistan
30	Panama
31	Peru
32	Philippines
33	Republic of Korea
34	Saudi Arabia
35	Serbia
36	South Africa
37	Sri Lanka
38	Tunisia
39	Ukraine
40	Uzbekistan
41	Venezuela
42	Vietnam

*COVID-19 vaccine reservation data sourced from UNICEF's COVID-19 Vaccine Market Dashboard, as of March 12, 2021. Available at: <https://www.unicef.org/supply/covid-19-vaccine-market-dashboard>. COVID-19

Anticipated vaccine distribution for Q1/Q2 2021 sourced from COVAX's interim distribution forecast, as of February 3, 2021. Available at: https://www.who.int/docs/default-source/coronaviruse/act-accelerator/covax/covax-interim-distribution-forecast.pdf?sfvrsn=7889475d_5.