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An ethical framework for global vaccine allocation:

The Fair Priority Model offers a practical way to fulfill pledges to distribute vaccines fairly and equitably

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Once effective coronavirus disease 2019 (COVID-19) vaccines are developed, they will be scarce. This presents the question of how to distribute them fairly across countries. Vaccine allocation among countries raises complex and controversial issues involving public opinion, diplomacy, economics, public health, and other considerations. Nevertheless, many national leaders, international organizations, and vaccine producers recognize that one central factor in this decision-making is ethics (1, 2). Yet little progress has been made toward delineating what constitutes fair international distribution of vaccine. Many have endorsed "equitable distribution of COVID-19…vaccine" without describing a framework or recommendations (3, 4). Two substantive proposals for the international allocation of a COVID-19 vaccine have been advanced, but are seriously flawed. We offer a more ethically defensible and practical proposal for the fair distribution of COVID-19 vaccine: the Fair Priority Model.

The Fair Priority Model is primarily addressed to three groups. One is the COVAX facility —led by Gavi, the World Health Organization (WHO), and the Coalition for Epidemic Preparedness Innovations (CEPI)—which intends to purchase vaccines for fair distribution across countries (5). A second group is vaccine producers. Thankfully, many producers have publicly committed to a "broad and equitable" international distribution of vaccine (2). The last group is national governments, some of whom have also publicly committed to a fair distribution (1).

These groups need a clear framework for reconciling competing values, one that they and others will rightly accept as ethical and not just as an assertion of power. The Fair Priority Model specifies what a fair distribution of vaccines entails, giving content to their commitments. Moreover, acceptance of this common ethical framework will reduce duplication and waste, easing efforts at a fair distribution. That, in turn, will enhance producers' confidence that vaccines will be fairly allocated to benefit people, thereby motivating an increase in vaccine supply for international distribution.

VACCINE NATIONALISM

Those who think countries will inevitably engage in "vaccine nationalism" (4) may deem an ethical framework for vaccine distribution among countries irrelevant. Public sentiment in some countries for retaining vaccine developed within their borders is strong, and many governments will also try to obtain vaccines produced elsewhere. But an ethical framework has broad relevance even in the face of nationalist attitudes. Rather than simply asserting that might makes right, governments typically appeal to national partiality: a country's right and duty to prioritize its own citizens.

Some defend national partiality as ethical (6–8). Fellow citizens share "associative ties," common governmental, civic, and other institutions, and a sense of shared identity (6, 7). Also, the legitimate authority of representative government officials inheres in their representing and promoting the interests of their citizens. Plausibly, these relations support allowing countries to prioritize citizens over foreigners for vaccines (6). Others view

national partiality as unethical: People's entitlement to lifesaving resources should not depend on nationality (9).

Regardless of whether some national partiality is ethical, unlimited national partiality is not (6–8). Associative ties only justify a government's giving some priority to its own citizens, not absolute priority (6). Moreover, associative ties extend across national borders, and citizens of different countries share common institutions (7). Finally, national governments have cross-border responsibilities to help satisfy fundamental needs like basic health care, particularly in a global health emergency (7).

Reasonable defenders of national partiality will differ on how much priority countries should give their citizens for vaccines. To establish the need for an equitable international distribution, it is unnecessary to determine an optimal level of priority. It is sufficient to identify a clear upper bound: Reasonable national partiality does not permit retaining more vaccine than the amount needed to keep the rate of transmission (Rt) below 1, when that vaccine could instead mitigate substantial COVID-19–related harms in other countries that have been unable to keep Rt below 1 through ongoing public-health efforts. The marginal benefit of additional doses of vaccine in a country able to keep Rt below 1 generally will pale in comparison to the potential benefits to countries whose Rt remains above 1—at least until booster vaccination is needed to maintain immunity. Hence, with Rt below 1, there will not be sufficient vaccine-preventable harm to justify retaining vaccine. When a government reaches the limit of national partiality, it should release vaccines for other countries. This makes an account of fair allocation among countries relevant to reasonable national governments.

THREE FUNDAMENTAL VALUES

Fairly distributing a COVID-19 vaccine among countries is a problem of distributive justice. Although governments will be the initial recipients of vaccine, fair distribution across countries must reflect a moral concern for the ultimate recipients: individuals. Three values are particularly relevant: benefiting people and limiting harm, prioritizing the disadvantaged, and equal moral concern.

Benefiting people and limiting harm is widely recognized as important across ethical theories. Realizing this value requires defining relevant benefits, measuring them, and assessing the relative urgency—the importance and time sensitivity—of countries' needs. A successful vaccine produces direct benefits by protecting people against death and morbidity caused by infection. It also produces indirect benefits by reducing death and morbidity arising from health systems overstressed by the pandemic, and by reducing poverty and social hardship such as closed schools.

Prioritizing the disadvantaged is a fundamental value in ethics and global health (10, 11). Realizing this value requires that vaccine distribution reflect special concern for people who are disadvantaged. Fairly distributing a COVID-19 vaccine internationally therefore requires assessing different types of disadvantage. Are the worst-off countries those experiencing the greatest poverty? Those where people have the lowest life expectancies?

Equal moral concern requires treating similar individuals similarly and not discriminating on the basis of morally irrelevant differences, such as sex, race, and religion. Distributing different quantities of vaccine to different countries is not discriminatory if it effectively benefits people while prioritizing the disadvantaged.

THE FAIR PRIORITY MODEL

To guide fair distribution of vaccine across countries, we propose the Fair Priority Model. Fair allocation must seek to mitigate future adverse effects of COVID-19. We focus on three types of harms directly or indirectly caused by COVID-19. First, COVID-19 kills people and causes permanent organ damage. Second, the pandemic indirectly harms health even for the uninfected by straining health care systems, raising mortality rates for common conditions, causing stress that harms mental health, and accelerating the spread of disease by hindering immunizations . Third, the pandemic has devastated the global economy, causing unemployment, economic decline, poverty, and starvation. Economics and health interact: Worsening economic conditions harm health, and a worsening pandemic harms the economy.

The pandemic forces allocators to decide where a vaccine's harm-reducing powers are most urgently needed. Three dimensions of harm are important. Are the harms irreversible? How devastating are they? And can they be compensated?

On these three dimensions, preventing death—especially premature death— is particularly urgent. Death is uniquely devastating, and those who die for want of vaccine cannot be compensated later on. Surveys further suggest popular agreement that a premature death that prevents someone's exercising their skills or realizing their goals later in life is worse than a death later in life (11, 12). Ethicists have similarly argued that preventing early deaths—deaths that are more prevalent in poorer countries—is both prudent and ethical (10, 13).

Death, however, is not the only irreversible and devastating harm. COVID-19 causes strokes and organ damage with long-term consequences. It also diminishes education and causes unemployment and poverty that impose long-term devastation.

The Fair Priority Model proceeds in three phases, preventing more urgent harms earlier (see the Table). Phase 1 aims at reducing premature deaths and other irreversible direct and indirect health impacts. Phase 2 continues to address enduring health harms but additionally aims at reducing serious economic and social deprivations such as the closure of nonessential businesses and schools. Restoring these activities will lower unemployment, reduce poverty, and improve health. Finally, phase 3 aims at reducing community transmission, which in turn reduces spread among countries and permits the restoration of prepandemic freedoms and economic and social activities.

Implementing each phase of the model requires determining the number of vaccine doses each country should receive and the order of receipt. The countries will then allocate vaccine internally to individuals. We expect that they will initially focus on areas where premature mortality can be reduced. Determining how many vaccine doses are allocated to each country depends on the marginal improvement in ethically relevant metrics that each dose

achieves. There are likely to be multiple distributions of vaccine as supply becomes available over time.

Five factors guide the choice of metrics for each phase: (i) fidelity to the underlying ethical values; (ii) simplicity; (iii) previous use in global health and development; (iv) ease of obtaining rapid but reasonable estimates as the pandemic evolves; and (v) sensitivity to relevant harms that are difficult to measure directly.

In phase 1, we propose using Standard Expected Years of Life Lost (SEYLL) averted per dose of vaccine as the metric for premature death (14). SEYLL calculates life years lost compared to a standardized reference life table—that is, a person's life expectancy at each age as estimated on the basis of the lowest observed age-specific mortality rates anywhere in the world.

SEYLL has three major advantages. First, it regards all deaths as important but earlier deaths as particularly important. Thus, it integrates the aims of limiting harm and of prioritizing the least advantaged, particularly because early deaths are more frequent in low-income countries and are a proxy for being disadvantaged overall (10). Second, SEYLL incorporates equal moral concern by valuing a life saved at a given age identically across countries, regardless of preexisting conditions or differences in national life expectancy. Finally, SEYLL is a standard metric used in global burden-of-disease calculations (14).

Phase 2 retains SEYLL as the health metric, treating it as a mortality measure and a proxy for morbidity. The novelty and uncertain long-term effects of COVID-19 preclude using more typical measures of morbidity, such as Years Lived with Disability.

No single socioeconomic metric integrates benefiting people and prioritizing the disadvantaged. Accordingly, we propose two metrics for phase 2 that capture overall economic improvement and the extent to which people would be spared from poverty. Because poverty is an extreme form of deprivation, people's moral claim to avoid poverty is especially urgent. The Fair Priority Model measures poverty by the projected reduction in the absolute size of the poverty gap per dose of vaccine, with the poverty line set at a uniform absolute level to be selected by the implementers. The poverty gap is the ratio by which the mean income of the poor falls below the poverty line; it accounts for both the prevalence and depth of poverty. Overall economic impact is measured by the projected absolute improvement in gross national income (GNI) per vaccine dose. Considering absolute improvement in GNI per dose is preferable to considering improvement in per capita GNI or percentage improvement in GNI, which would favor countries with smaller populations or economies and permit unnecessary harm without prioritizing the disadvantaged. Moreover, increased GNI in one country will also lead to cross-border gains through trade, employment, and transfers. These simple economic metrics combine to ensure that vaccines prevent substantial harms and prioritize the disadvantaged.

In phase 3, countries with higher transmission rates are initially prioritized, but all countries should eventually receive sufficient vaccine to halt transmission, which is projected to require that 60 to 70% of the population be immune.

FLEXIBILITY OF THE MODEL

Specifying how vaccines should be allocated will require integration of the model with data and empirical forecasts. For instance, in phase 1, minimizing SEYLL might mean immunizing those at high risk of death, those most likely to transmit infection, or those most at risk of initial infection. The vaccination strategy that best averts SEYLL depends on each country's demography, prevalent comorbidities, and health system capacity, as well as open scientific questions: Will vaccines reduce severity but not transmission, be less effective in the elderly, or require periodic boosters? The WHO's Strategic Advisory Group of Experts is currently evaluating how much harm each strategy prevents. Similarly, the World Bank is evaluating the impact of COVID-19 on countries' economic activity and world poverty. These or similar organizations can provide the analytic forecasts to guide actual distribution of the vaccines over time by the COVAX facility or vaccine producers. By specifying metrics that should guide allocation and monitoring the vaccine's effect on outcomes, the Fair Priority Model naturally accommodates changes in our knowledge of COVID-19.

How much vaccine should be distributed in each phase? Empirical uncertainty makes it impractical to fully specify the transition between phases now. However, distributors might set the first transition at the point where a vaccine successfully reduces the burden of COVID-19 from an emergency to the level of established health challenges. For example, phase 2 might commence once a vaccine reduces worldwide SEYLL due to COVID-19 to a level analogous to the burden of influenza. Similarly, the transition to phase 3 might begin once additional vaccines either successfully narrow the poverty gap to prepandemic levels or encounter substantially diminishing returns in that effort. Because the distribution of vaccine doses among countries is linked to the impact of the vaccine on common worldwide metrics, all countries should progress to the next phase approximately simultaneously. This is approximate; some countries may struggle to control their outbreaks even with vaccine, but that should not preclude the rest of the world progressing to the next phase. Although we have delineated the ethical framework and metrics, epidemiological and economic assessments using the best available data will be needed to help determine when a phase should be considered complete.

COMPARISON WITH OTHER PROPOSALS

Two schemes for the international distribution of COVID-19 vaccine have been proposed. First, the WHO suggests that countries receive doses proportional to population in phase I (15). Phase I begins with 3% of each country's population receiving vaccines, and population-proportional allocation continues until every country has vaccinated 20% of its population. The COVAX facility currently accepts this proposal, which is undergoing revision (5).

A population-based distribution appears to express equal moral concern and may appear to be politically tenable. However, it mistakenly assumes that equality requires treating differently situated countries identically rather than equitably responding to their different needs. Equally populous countries can face markedly different levels of premature death and economic devastation from COVID-19. Aid to countries typically is provided in

approximate response to the severity of problems. Providing aid merely in proportion to population is unjustified and almost never used. For instance, it would be unethical to allocate antiretrovirals for HIV on the basis of population, rather than on HIV burden. Likewise, a fair distribution of COVID-19 vaccines should respond to the pandemic's differential severity in different countries.

The second proposal distributes vaccine to countries according to the number of frontline health care workers, the proportion of population over 65, and the number of people with comorbidities in the country (15). This proposal seems to prioritize protecting those judged most likely to die and preventing health system collapse due to health care workers' illness. But it is an empirical question whether this prioritization optimally reduces death, let alone premature death or serious economic harms. Preferentially immunizing health care workers may not substantially reduce harm in higher-income countries where personal protective equipment effectively protects health workers. Instead, vaccinating those whose housing or occupation or age puts them at greatest risk of spreading infection, or people at highest risk of becoming infected, might best prevent harm. Only data can determine which approach best fulfills the ethical value of reducing premature deaths.

Further, because the second proposal does not use SEYLL to correct for disadvantages due to differential national life expectancy, it compounds disadvantage compared to the Fair Priority Model. Since low- and middle-income countries have fewer older residents and health care workers per capita than high-income countries, this scheme allocates less vaccine to countries already disadvantaged by weaker health systems and shorter average life spans.

OBJECTIONS CONSIDERED

We consider three potential objections to the Fair Priority Model. First, some might argue that countries should receive vaccine only if they can provide assurance that they will distribute it to minimize premature deaths and mitigate economic harms, and have the infrastructure to effectively do so.

Allocating vaccine doses to countries lacking the infrastructure to administer them would unjustifiably waste a lifesaving resource. Consequently, fair allocation may be conditional on infrastructural capacity and might also require efforts to help poorer countries develop such infrastructure.

Conditioning vaccine on fair distribution within countries is more problematic. A fair distribution of emergency supplies ultimately aims at helping individuals: They are the ones who live or die, prosper or are impoverished. Some authoritarian countries may do an excellent job of distributing vaccine to minimize health, economic, and other harms. As long as individuals benefit, fair global distribution among countries should neither require that intranational distribution of a vaccine be perfectly just nor seek to punish unrelated injustices. However, some countries may grossly mismanage their domestic vaccine allocations, by, for instance, hoarding doses for a ruling elite. Addressing such hoarding may require making actual vaccine distribution among countries in subsequent phases or subsequent tranches within a phase conditional on a country's having distributed

the vaccine reasonably fairly to its members. But outside of extreme cases, withholding vaccines to enforce conditionality inflicts disproportionate burdens, making conditionality rarely appropriate.

Second, some might suggest that the Fair Priority Model unfairly disadvantages countries that have effectively suppressed viral transmission without a vaccine and rewards those who have responded ineffectively.

A fair distribution of vaccine among countries must mitigate future health, economic, and other harms spawned by COVID-19. It should not be backward looking, punishing or rewarding countries for their COVID-19 response or aiming to redress past injustices. The individuals whose lives and livelihoods are at risk often had little say in their governments' response to COVID-19. Further, medicine espouses treating people regardless of responsibility for their illness. Smokers who develop lung cancer and malaria patients who did not use bed nets are not denied care.

Moreover, though the Fair Priority Model recommends allocating vaccine on the basis of expected benefits, it does not exclude countries that have effectively suppressed COVID-19 transmission by making economic sacrifices. If these sacrifices translate into ongoing economic harms that vaccines can alleviate—an empirical question—they are addressed in phase 2. Waiting until phase 2 to address these economic harms is appropriate because premature deaths are more urgent and less compensable. Furthermore, development aid might address the effects of economic sacrifices more effectively than COVID-19 vaccines.

Third, some might worry that the metrics are too uncertain and demanding to calculate, or could perversely incentivize countries to exaggerate the spread and harm of COVID-19 to secure more vaccine earlier.

In a novel, rapidly evolving pandemic, any approach sufficiently sophisticated to meaningfully operationalize ethical values will require approximations as well as judgments about the relative weight to assign different metrics, such as SEYLL and the poverty gap. Simple metrics like population size avoid approximations and trade-offs but fail to measure what morally matters. Moreover, the proposed metrics are routinely used in global health, and basing vaccine distribution on these metrics will encourage collection and reporting of accurate data on changes in mortality and poverty related to COVID-19.

Regarding perverse incentives, countries are unlikely to exaggerate the spread and harm of COVID-19 to secure more vaccine. Any temptation to exaggerate suffering from the pandemic will be tempered by a country's need to reassure its public, visitors, investors, and others about control of COVID-19 to stimulate economic activity and allow travel. Also, as Taiwan and New Zealand show, there are notable soft power advantages associated with an effective pandemic response.

CONCLUSION

The Fair Priority Model is the best embodiment of the ethical values of limiting harms, benefiting the disadvantaged, and recognizing equal concern. The responsibility

for implementing the model rests with countries, international organizations, and vaccine producers. They need to use the cooperative mechanisms that have been created to deal with the pandemic, such as the COVAX facility. Organizations also have indispensable roles in empirically assessing how vaccine distribution in fact affects countries with respect to metrics like SEYLL, poverty, and GNI. Ultimately, the model offers governments, international organizations, and vaccine producers a practical way to fulfill their pledges to distribute vaccine fairly and equitably, and make their words a reality.

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A family member prays at a relative’s grave in Comas, in the outskirts of Lima. Peru has one of the highest COVID-19 death tolls among countries in Latin America and the Caribbean region.

Three phases of Fair Vaccine Distribution

DISTRIBUTION PHASE	PRIMARY AIM	METRIC TO DISTRIBUTE VACCINE DOSES	HOW THE METRIC FULFILLS VALUES	PRIORITIZATION
Reducing premature deaths	Reducing foreseeable premature deaths directly or indirectly caused by COVID-19.	Standard expected years of life lost (SEYLL) averted by administering vaccine.	Prevents substantial harms and gives priority to the worst-off by giving weight to premature deaths. Recognizes equal moral concern by valuing a life saved at a given age identically across countries.	Priority to countries that would reduce more SEYLL per dose of vaccine.
Reducing serious economic and social deprivations	Reducing serious economic, social, and fatal and nonfatal health harms caused by COVID-19.	SEYLL averted. Reduction in absolute poverty measured by poverty gap. Declines in gross national income (GNI) averted by administering vaccine.	Prevents harm by recognizing a wide range of economic, social, and health deficits. Gives priority to the worst-off by prioritizing people in poverty.	Priority to countries that would reduce more poverty, avert more loss of GNI, and avert more SEYLL per dose of vaccine.
Returning to full functioning	Ending community spread of COVID-19.	Ranking of different countries' transmission rates.	Prevents harm and gives priority to the worst-off by prioritizing countries with higher transmission rates.	Priority to countries with higher transmission rates.