Increasing Equity in the Transnational Allocation of Vaccines Against Emerging Pathogens: A Multi-Modal Approach

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Abstract: This article proposes the adoption of a multi-modal system for allocating vaccine doses during large transnational outbreaks of infectious diseases. The chosen allocative criteria (public health need; country-income level; qualification through funding; and, subsidiarily, a modified lottery system) are adapted from a current embodiment of allocative multi-modality outside the context of public health: the New York City Marathon.

I. Introduction

Current approaches to producing and distributing medicines needed to prevent or respond to outbreaks caused by emerging pathogens[1] rely overwhelmingly on market-based dynamics, as well as laws, policies and worldviews that artificially draw lines between geopolitical areas.[2] As a result, the allocation of critically needed medicines during large transnational outbreaks has long been skewed to prioritize populations in countries with the greatest bargaining power,[3] as opposed to those in regions where demand is the greatest by public health criteria.

The COVID-19 pandemic, which has provided the latest illustration of this problem in the form of "vaccine nationalism"[4] or "vaccine colonialism,"[5] has also rekindled interest in the use of collaborative forms of international allocation of scarce medicines. This was illustrated by the swift formation of an international facility (called COVID-19 Vaccines Global Access, or simply COVAX) tasked with the purchase and equitable distribution of newly developed vaccines against COVID-19,[6] which nonetheless faced numerous hurdles in increasing the availability of much-needed medicines to populations in lower-income countries.[7]

In Part II the article briefly describes and contextualizes the problem of access to vaccines during large transnational outbreaks of infectious diseases, which are typically addressed once a pandemic or epidemic is already underway through a bi-modal system: first, through the dynamics of unbridled market competition, in which higher-income countries resort to bilateral contracts to capture as many vaccine doses as possible;[8] and secondarily, through corrective procurement organized through international organizations operating in a politically and resource-

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constrained space[9] (as has been the case with COVAX throughout the COVID-19 pandemic).

The article then makes the case that preparedness for upcoming pandemics and epidemics should include a shift towards proactive interventions aimed at promoting the adoption of more equitable forms of vaccine allocation in contexts of scarcity (Part III). It argues that it is both possible and desirable to negotiate and implement a framework for the allocation of scarce vaccine doses during pandemics and large-scale epidemics before vaccine scarcity becomes a problem and competing claims for limited doses arise among unequal players in the international arena — which is to say that a workable framework must be bargained over before a pandemic or epidemic begins, as opposed to the current practice of only engaging in allocative debates after a public health crisis is underway.

II. Inequities and Long-term Asymmetries in the Transnational Allocation of Vaccines During Pandemic- and Epidemic-Spiked Markets

When a new pathogen triggers a pandemic or other form of large-scale transnational outbreak, a race to discover and manufacture a new vaccine typically ensues.[10] The resulting output is often insufficient to meet pandemic- or epidemic-spiked demand, at least during the initial and sometimes intermediate stages of these public health crises.[11]

After distilling the major traits of this allocative scheme (and noting the analogical limitations of this case study), the article sets forth a proposal for the creation of a multi-modal framework tailored to the problem of inequitable transnational allocation of pandemic and epidemic vaccines. The proposal envisions the concurrent adoption of four allocative categories based on: 1) public health need; 2) country-income level; 3) qualification through funding; and 4) a subsidiary, modified lottery system.

In order to create such a framework, Part IV proposes the adoption of a multi-modal approach designed to infuse greater equity into the frameworks that govern the allocation of pandemic and epidemic vaccines. The article looks outside the context of public health for structuring principles of multi-modal allocative schemes: specifically, it examines the case of the allocation of participation slots at a disproportionately over-subscribed international event — the New York City Marathon. After distilling the major traits of this allocative scheme (and noting the analogical limitations of this case study), the article sets forth a proposal for the creation of a multi-modal framework tailored to the problem of inequitable transnational allocation of pandemic and epidemic vaccines. The proposal envisions the concurrent adoption of four allocative categories based on: 1) public health need; 2) country-income level; 3) qualification through funding; and 4) a subsidiary, modified lottery system.

On its own, such an allocative system would, in all likelihood, be insufficient to eliminate all expressions of vaccine nationalism that are detrimental — sometimes even antithetical — to public health. It would, however, help mitigate these problems by incorporating more public health-based and equity-enhancing levers into the frameworks that govern the allocation of vaccines in contexts of pandemic and epidemic scarcity.

While the equitable distribution of scarce vaccines should in principle be based on bioethical and public health criteria, the actual distribution of vaccine doses in the context of pandemic and epidemic scarcity tends to disproportionately reflect the dynamics of country-driven purchasing power and geopolitics.[12] The COVID-19 pandemic provided the latest embodiment of this phenomenon, with the vast majority of vaccine doses produced during the earlier stages of the pandemic being bought and used disproportionately by higher-income countries.[13] Even when the public health need for COVID-19 vaccines was higher amidst populations in lower-income countries, the bulk of existing vaccine continued to be acquired by the governments of higher-income countries.[14] A study conducted by researchers at Duke University in 2020 found that "most people in low-income countries will be waiting until 2024 for COVID-19 vaccinations if high-income countries keep engaging in what some are calling 'vaccinationalism'."[15] Similarly, during the race to develop a vaccine against swine flu in 2009, higher-income countries placed advance orders capturing nearly all of the projected vaccine supply.[16] Only

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when it became apparent that the 2009 pandemic would not be as prolonged and severe as initially thought did these countries offer to donate vaccine doses to lower-income countries.[17]

The terms "vaccinationalism," or "vaccine nationalism" have been coined to reference situations in which the allocation of vaccine doses reflects political and sovereignty-related distinctions, rather than public health need.[18] In addition to being largely detached from the epidemiology and geography of a given pandemic or epidemic, these distinctions further perpetuate the disparate and inequitable treatment of populations in lower-income countries, which are made to wait for access to existing vaccines — even in cases in which a pandemic or epidemic affects them the most.[19] The expression "vaccine colonialism" gained momentum during the COVID-19 pandemic to shed renewed light on this phenomenon.[20]

In addition to being inequitable and detached from public health criteria, current modes of allocation of scarce vaccines during pandemics and epidemics are asymmetrical — from a market perspective — in ways that are difficult to correct. Given that the *de facto* operative criterion dominating the transnational allocation of scarce vaccines hinges on a distinction between lower- and higher-income markets, the forces driving allocation are relatively stable over time. Absent fundamental social, political, and economic changes, we can expect allocation in the next pandemic or large-scale epidemic to largely follow the distribution pattern observed during the COVID-19 and 2009 swine flu pandemics. That this dividing line — based on sovereignty and nationalism constructs, geopolitics and the long-arm of colonialism — should align naturally with the distribution of public health need for a vaccine in a given pandemic or epidemic is highly unlikely. The asymmetries generated by the dominant operative allocative criteria are thus likely to persist.

III. Vaccine Allocation as a Market Problem

Problems surrounding the allocation of scarce pharmaceuticals are often conceptualized, first and foremost, as problems pertaining to the domains of bioethics, public health policy, and related fields[21] — and rightly so. At yet another level, however, they pose significant challenges for profit-driven markets.[22] In the case of vaccines against emerging pathogens, this happens at two levels: first, at least during the early stages of a pandemic or epidemic, the supply is vastly insufficient to meet demand; and second, the way these markets operate leads to an allocation of available resources to where they might not be needed the most.[23]

Still from a market perspective, vaccines against emerging pathogens face unique challenges. Unlike the market for vaccines for which there is relatively stable demand over time (e.g. vaccines routinely used against childhood diseases), the market for vaccines needed during pandemics and epidemics can only arise after a pathogen emerges and causes an outbreak — an event that, however probable, remains future and uncertain.[24] Likewise, the duration and public health burden of the event, should it occur, are also hard to predict.[25] This leads to a scenario in which these vaccines are severely undervalued prior to the onset of a major public health crisis, but typically valued very highly during the early stages of such a crisis.[26]

While they have been conceptualized as problems of a mismatch between supply and demand,[27] prescriptive approaches to the transnational allocation of scarce vaccines reflecting these market dynamics have been limited. The primary way to do so is through international procurement of vaccines: this model has been used by GAVI, the Vaccine Alliance — an international public–private partnership based in Geneva — to purchase and distribute vaccines to children in lower-income countries since 2000;[28] and it served as a partial blueprint for the formation of COVAX during the COVID-19 pandemic.[29] Under this model, an actor on the demand side places large-volume orders for vaccine doses on behalf of several other actors — in the case of pandemic vaccines, these orders are placed even before the vaccines are ready for commercialization, as was the case with COVAX, which placed orders on behalf of multiple countries with several vaccine manufacturers working on different types of COVID-19 vaccine candidates.[30] This strategy offers three advantages: bulk ordering creates volume beyond what individual countries are typically able to generate by themselves; it also allows the facility to place orders for more than one type of vaccine, thus spreading the risk associated with the investment; and, by providing funding to manufacturers, it helps finance late-stage development and vaccine rollout.[31]

While important and ripe for further development, current models of international procurement of vaccines for pandemics face several limitations, largely stemming from the fact that they are negotiated when a public health crisis is already underway.[32] Negotiations on how to structure procurement occur under a compressed timeline and are subject to geopolitical pressures. Funding, which needs to materialize quickly, tends to be limited.[33] For instance, the stated goal of COVAX at the outset was to provide doses for

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at least 20 percent of participating countries[34] — an important ambition, but also one that showcases the current limitations of the international procurement model, and which still leaves the provision of most doses to fall under other models.[35]

In the absence of strong international coordination, contractual bilateralism thus becomes the dominant mode of matching (limited) supply and (overwhelming) demand: countries that have the power to do so capture the bulk of existing vaccine doses by entering into purchase agreements directly with vaccine suppliers.[36] This power is both economic (the sheer ability to pay for numerous orders of vaccine doses) and non-economic (access to actors and other players that stems from privileged relationships cultivated in the international arena over the course of decades or centuries).

Bilateral contracts have thus become, and remain, the primary mode of allocation of vaccines against emerging pathogens in context of scarcity.[37] Nascent forms of *ad hoc* international procurement are poised to play an increasingly important role in countering the asymmetries and inequities generated by bilateralism. For now, however, their role remains limited.

IV. The Need for a Multi-Modal Approach to Allocative Problems

So far, the predominant approaches to correcting asymmetries and inequities in the allocation of vaccines against emerging pathogens have been implemented through interventions that are largely negotiated and deployed when large-scale public health crises are already underway. First, there has been the formation of *ad hoc* procurement strategies, as noted in the previous section,[38] as well as donations, taking place either as stand-alone interventions, as was the case of donations of vaccine doses during the 2009 swine flu pandemic, or as part of concerted procurement, as was the case of donations to COVAX during the COVID-19 pandemic.[39]

Second, there have been repeated calls for the formation of structures that will allow for some degree of *ex ante* preparation for vaccine scarcity in future transnational outbreaks.[40] These include the ongoing negotiations for a pandemic treaty.[41] They also include the possibility of the establishment of a permanent, or at least long-term, procurement facility focused on the development of vaccines against emerging pathogens.[42] This could be accomplished either by the formalization of COVAX into a permanent structure, or through the creation of a new structure.

Whichever intervention(s) might be adopted, the question remains of how to implement a system that makes the allocation of existing doses less dependent on market-driven bilateralism — or, at a minimum, that bolsters the relative weight of other modes of allocating scarce vaccines, particularly those embedded into transnational procurement schemes. A possible answer to that question might be that the preferred embodiment of such a system would be through centralization and global or quasi-global coordination, in which one or more decision-makers adopt allocative criteria that better reflect public health needs. Given the strong, recurring preference for bilateralism and vaccine nationalism displayed by the wealthier and politically dominant actors in the system over the last several decades, it seems unlikely that these same actors would willingly embrace such a systemic change.

The article therefore explores a possible solution aimed at increasing equity in the transnational allocation of vaccine doses during pandemics and epidemics — one that combines different allocative pathways or modes, catering both to public health criteria and market-driven considerations — and further offering the possibility of blending these criteria with additional ones that pertain neither to public health nor economics (e.g. randomness, as further detailed below).

Importantly, it is useful to recall that the particular type of vaccine market that is the subject of this article differs from other vaccine markets in its future nature, potential lack of permanency, and overall uncertainty surrounding most metrics typically used to project both short- and long-term demand.[43] The idea animating the proposal articulated in Part VI is that, because these vaccines are undervalued *before* a pandemic or epidemic causes a spike in demand, there is more room for bargaining precisely during this period in which the goods at stake are undervalued and the "fear factor" brought about by a major public health crisis has not yet kicked in — that is, before the next pandemic or transnational epidemic occurs.

In addition to *ex ante* bargaining, the proposal also relies on the idea of combining values and agendas. The bilateral approach tends to predominate over others when decisions about the allocation of scarce vaccines have to be made in a compressed timeline and the goods are highly valued at that very moment.[44] Yet, with *ex ante* bargaining providing actors with some time to seek out some form of compromise for an as-of-yet future market, there is greater opportunity to reconcile competing claims. For example, a vaccine manufacturer that receives funding to develop a vaccine during the pre-pandemic period may agree to commit to provide a set percentage of the future out-

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put to a facility engaged in international procurement and equitable allocation of pandemic vaccines. Before a market exists for a particular vaccine, both the manufacturer and the facility benefit from the arrangement: the former enters into a contractual relationship that will guarantee monetization of its product (setting this manufacturer apart from those that have not pre-committed vaccine doses before an outbreak occurs, and who will have to find buyers for their vaccines) and the latter populates its vaccine pipeline at no immediate cost in preparation for an outbreak. Using allocative criteria that combine disparate values and agendas — and, as discussed below, enabling those who bargain to assign different importance to each allocative method — increases the viability of the proposal compared to solutions that focus solely on one type of value or agenda.

Current debates about international vaccine procurement and a possible pandemic treaty signal a willingness from a large number of countries to contemplate some degree of agreement about the allocation of drugs and vaccines in future pandemics and epidemics.[45] The proposal outlined below could be incorporated into the mechanisms already under consideration: for instance, COVAX or its successor could administer the allocative process, or the treaty could create an *ad hoc* structure for that purpose. The focus of this article is not on the architecture of the administrative body, but rather on the process for allocating vaccine doses that are globally available at a given point in time during a pandemic or epidemic.

That process, as proposed here, relies on the combination of several allocative criteria. Moreover, these criteria are tailorable — that is, they can be weighted differently by the bargainers to reflect priorities and compromises. In order to explore the combinatory and tailorable nature of the proposal, Part V now turns to an embodiment of a multi-modal approach for the allocation of scarce goods outside the context of global health: one that has already been implemented, and that illustrates how to combine and tailor allocative criteria. Part VI then develops a framework for the implementation of a multi-modal system designed specifically to allocate scarce vaccines during pandemic and epidemics.

V. A Multi-Modal Approach: The Example of the Allocation of Participation Slots at Major Marathon Races

The chosen case study to illustrate the aspects outlined above is the allocation of participation slots at major marathon races — and in particular the New York City Marathon, which is one of the most sought-after events in the world.[46] As seen below, when faced with an exponential increase in demand, the event organizers adopted a multi-modal scheme to make allocative decisions. The concept of multi-modality is used in this article as referring to the concurrent adoption of more than one decision-making pathways. In the case of the New York City Marathon, multi-modality refers to the combination of four methods of allocation of participations slots, each reflecting a different principle and operative set of values.

Of course, fundamental differences exist between allocating participation slots for which there is overwhelming demand from participants around the globe and allocating scarce vaccine doses to populations experiencing different degrees of medical need across the globe. Even if viewed strictly from a market perspective — the encounter of supply and demand — demand for the former is recurrent (on yearly basis) and relatively stable, making it possible to project future markets with some degree of certainty. This stands in sharp contrast with demand for vaccines against emerging pathogens, which is unpredictable and *a priori* non-cyclical.[47]

There are likewise notable differences on the supply side. Even though logistics constrain the possibility of significant increases in the number of slots available for runners, the number of participation slots available for a given marathon faces significantly less extrinsic pressures and uncertainty than the supply of vaccines doses during a pandemic or epidemic. In addition to having to be developed and undergo a testing and review period,[48] the latter are typically affected throughout the manufacturing process by logistical and supply chain limitations,[49] allied to the volatility of funding and policy support for vaccine rollout.

Setting these differences aside, the focus of this Part is on the combinatory and tailorable aspects of this particular embodiment of a multi-modal system already in use to navigate a problem of allocation of scarce resources.

For context, the major urban marathons have become extremely sought-after events over the past few decades, with demand for participation vastly outstripping the number of available slots.[50] Presently, most marathons use a combination of criteria to determine how to allocate participation slots. For instance, the Boston Marathon allocates slots according to two criteria: qualification times and running for charity.[51] The New York City Marathon uses four criteria, known as "entry methods."[52] More than the higher number of criteria, New York stands apart because the entry methods have grown to factor in criteria that are often used on an "either/or" basis: sports-related and

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-unrelated; charity-based and pay-to-run approaches; and geographical criteria reflecting local, national and international interests. For these reasons, it provides a useful window into the implementation and tailoring of competing allocative criteria.

The first method of allocation of slots is through qualification based on performance, which is assessed by time. Runners awarded a slot through this method are required to compete in a listed qualifying event (a "certified half-marathon or marathon") and meet pre-determined time standards.[53] These standards vary across three categories (men, women, and non-binary) sub-divided into age groups.[54]

The second method — added during the 33rd edition of the New York City Marathon in 2002 as demand for slots kept increasing — is also based on performance at a combined, large number of qualifying events, but not on timing.[55] Known as the "9+1 program," this method requires runners to "register for and complete" in nine qualifying races during a pre-determined eligibility period, as well as volunteer at a "qualifying opportunity."[56] 9+1-qualifying races take place in or around New York City. While runners are required to finish nine races to qualify for the marathon, their times are not taken into account. The purpose of this method is to allow for the allocation of participation slots to runners showing a deep commitment to the sport, as well as some degree of geographical connection to the New York area.

The third method of allocation is through a lottery system.[57] Participation slots are awarded to entrants chosen at random. For the 2022 edition, there were three separate lottery drawings according to the applicants' combined nationality and residency: one for applicants residing within 60 miles of New York City ("NYC metro area applicants" category); another for United States citizens living outside the New York City metropolitan area (the "national applicants" category); and another one for "international applicants."[58] The current embodiment of the lottery system thus combines randomness with geographic criteria, both domestic and international.

The fourth and final method of allocation is through a monetary contribution.[59] This method is two-fold. One option requires aspiring participants to fundraise for one of the marathon's pre-selected charities.[60] Runners who meets the specific fundraising goals of their selected charity are then given a slot to the marathon. Minimum amounts vary. For instance, in 2022, the Cystic Fibrosis Foundation requested a minimum of $4,000 per participant,[61] while Amref Health Africa set the minimum contribution at of $2,500 per participant.[62]

The other option available under this method is reserved to runners who reside outside the United States.[63] International runners may purchase a "travel package" from an official "International Tour Operator" listed on the Marathon's website.[64] The packages include a guaranteed participation slot, and must also include lodging, flight, or a combo thereof, so that participation slots cannot be sold as standalone items.[65]

Having surveyed the four pathways on the supply side of a specific system, the article now turns to the question of how a multi-modal system for the allocation of scarce vaccines during pandemics and epidemics could be construed.

VI. Proposed Approach: A Multi-Modal System for the Transnational Allocation of Vaccines Against Emerging Pathogens

While the specific design of the multi-modal system for allocating vaccines may be configured in different ways — much like the methods for entering the New York City Marathon — the embodiment of the proposal presented here seeks primarily to provide a framework that balances competing interests currently expressed in the transnational allocation of vaccine doses.

In this spirit, the article suggests the transnational allocation of doses of vaccines against emerging pathogens in the context of pandemic or epidemic scarcity through the creation of four allocative categories based on: 1) public health need; 2) country-income level; 3) qualification through funding; and 4) a subsidiary, modified lottery system.

The first mode would reserve a set percentage of the existing supply of vaccine doses for allocation according to criteria based solely on public health considerations. Albeit non-exclusive, this category is the one that most closely reflects bioethical principles for the allocation of scarce medical resources. To be sure, there is a plurality of guiding principles put forth by bioethicists in this context. For example, writing during the early stages of the COVID-19 pandemic, Ezekiel Emanuel and colleagues summarized the "four fundamental values" for resource allocation during a pandemic as those of "maximizing the benefits produced by scarce resources, treating people equally, promoting and rewarding instrumental value, and giving priority to the worst off."[66] This proposal suggests that the entity designated to administer the system should assess public health need with reference to countries or regions bearing the most significant burden of a pandemic or epidemic.

The concepts of significance and burden (infection and/or mortality rates, strain to health systems, etc.) can be established *ab initio* with more or less granu-

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larity: providing a criterion in the allocative framework itself from the start reduces uncertainty, but does not take into account the specific characteristics of a newly emerged pathogen and the contours of the outbreak it has caused; whereas populating these concepts when demand for vaccines begins adds an additional step to the deployment of the framework when needed, but allows for greater calibration of the decision-making process. Overall, the operative principles used to implement this allocative mode should be consistent with the values alluded to above and reflect a sound application of epidemiological science.

Cumulatively with the public health-based mode described above, the second mode would reserve a set percentage of the existing supply of vaccine doses for allocation to lower-income countries. While the previous category reflects the geography of an outbreak, it does not factor in the *de facto* effects of vaccine nationalism and colonialism, which recurringly result in the disproportionate allocation of vaccine doses to higher-income countries during the first stages of an outbreak, irrespective of public health need. Operating in parallel to the category that caters to epidemiological and public health concerns, this second allocative mode directs a set percentage of vaccine doses to lower-income countries affected by the outbreak, even if public health need is greater elsewhere. The rationale for this allocative method is to counter the inequitable effects of bilateralism, which invariably are supported by populations in lower-income countries: when pandemics or other outbreaks affect both lower- and higher-income countries, the latter are likely to continue to make as extensive a use as they possibly can of bilateral contracts between their governments and vaccine manufacturers, as has historically been the case. This category thus seeks to respond to the entrenched market imbalance between countries with the highest bargaining and purchasing power and those competing for vaccine doses in an unlevel playing field. A pre-set list of countries qualifying as lower-income would be agreed upon in advance and could be modeled after already in-use taxonomies, such as the list published every three years by the Organization for Economic Co-operation and Development (OECD). As with the OECD categorization, qualification could be periodically revised. Finally, should no qualifying lower-income countries be affected by a particular outbreak, or should they have no need for as many vaccine doses as those allocated through this mode, the category would not apply and doses would be allocated according to the remaining criteria.

Cumulatively with the previous two modes, the third mode would reserve a set percentage of vaccine doses for allocation to countries that have used public funds to support R&D on the vaccines allocated through the multi-modal system. Rather than reflect public health need or seek to counter systemic inequality, this mode takes into account the political economy of the contemporary vaccine development and distribution ecosystem. The market-driven behavior of higher-income countries during past vaccines races indicates that they are highly unlikely to support allocative frameworks that do not reflect some form of national-based interest — whether public health-, economy- or industry-related, if not all of these. In recognition of the asymmetrical bargaining power of countries with an existing vaccine manufacturing industry, this allocative mode would thus reserve a set percentage of vaccine doses for these countries, but only in cases in which they have funded the research and development (R&D) of one of the vaccines being distributed through the multi-modal system. It is also worth noting that the COVID-19 pandemic has rekindled the development or growth of vaccine manufacturing capabilities in several lower-income countries, to whom this mode would apply if implemented. As further discussed below, this mode should not be construed in a way that would override the other modes of allocation — if anything, it might be given lesser weight in the overall system, should the political economy permit it.

Finally, the fourth mode, if implemented, would reserve a set percentage of vaccine doses to be allocated through a lottery. Lotteries introduce randomness to the decision-making process. They have been studied in the context of the allocation of scarce medical resources as a way to adjudicate a resource facing competing claims when it is difficult to discern which one is worthier or to apply other criteria (in the case of unweighted lotteries); or as a way to preserve randomness in the decision-making process to adjudicate a resource facing competing claims that are assigned different importance (in the case of weighted lotteries). There have been several proposals for the use of lotteries as a means of allocating scarce medical resources during the COVID-19 pandemic,[67] including with specific regard to COVID-19 vaccines.[68] The article is agnostic on whether a lottery model *should* be implemented as a fourth allocative mode, as that choice would relate to the overall design of the system, as well as the specificities of the bargaining process — a multi-lateral (ideally global) process in which unequal national actors[69] trade off philosophical approaches, as well as political and economic agendas, in the international arena. For these reasons the article merely notes the possibility of a lottery as a subsidiary mode of allocation in the multi-modal system. If adopted, a

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lottery for the allocation of vaccine doses would then be used cumulatively with the other three modes. The lottery can be unweighted, giving each country affected by a pandemic or epidemic an equal chance at a pre-set percentage of vaccine doses; or weighted, giving certain countries a greater chance being adjudicated vaccine doses. In turn, a weighted lottery can assign greater importance to one of the criteria used in the other modes, thus enhancing a preference for a particular operative criterion (e.g. by increasing the odds of countries where public health need is deemed greater, or those of lower-income countries); or it can be structured according to criteria not contemplated in the proposed model.

In addition to combining cumulative modes of qualifying for vaccine doses, the proposed approach also configures a mix-and-match system that can be weighted to assign greater importance to one or more modes. In an ideal scenario, allocative modes detached from public health principles or concerns with longstanding inequities in the allocation of vaccines to populations in lower-income countries *should* be assigned a lower value in the system. For instance, if the total weight of the system is set at 10 in a four-mode embodiment of the proposal, instead of assigning a factor of 2.5 to each mode, it is possible to assign a factor of 3 to the first and second modes and 2 to the third and fourth ones — or any other permutations, including assigning a preponderant (e.g. a factor of 7 out of 10 to the public health mode).

Even though it faces these limitations, a multi-modal system can provide a more flexible and politically viable alternative to current approaches to lessening the inequitable effects produced by the current bi-modal framework relying primarily on bilateralism and secondarily on (limited) international procurement. Its tailorable and bargainable nature allows for experimentation, with the *ex ante* approach removing some of the market pressures that arise during pandemics and epidemics. As such, it is a tool worth considering by those seeking to counter the exclusionary effects — and their disproportionate toll on populations in lower-income countries — generated under the *status quo*.

Having described the four proposed modes, the article now turns to the question of the relationship between the modes and the functioning of the system as a whole. As noted above, the proposal articulated here conceives of the modes as cumulative. It does so to account for, but lessen, the impact of recurring and probable future behaviors favoring the allocation of vaccine doses according to market-driven principles — and marry them with core public health-driven ones. A cumulative system allows for bargaining through tailoring and for a possible exchange of trade-offs: countries with similar interests may have to concede some components relative to one mode (e.g. accept a lesser weight for income-based criteria in a lottery, if implemented) in order to bargain for others (e.g. that the mode of allocation based on public health need hold greater weight, as further detailed below). But given of the cumulative nature of the system, the outcome — however far from perfect from a bioethical perspective — will not be a zero-sum-game, unlike the current practice of vaccine nationalism.[70]

In addition to operating according to the dynamics described above, the multi-modal system would have to be administered through an international structure capable of 1) representing disparate national- or regional-level interests, 2) facilitating and coordinating bargaining processes and 3) overseeing the allocation of vaccine doses according to the chosen embodiment(s) of the multi-modal scheme. In light of the need for pre-outbreak negotiations, this structure would necessarily have to be created before the onset of a pandemic or large epidemic. A possible way to develop such a structure would be to rely on a pre-existing one: COVAX was created reactively and focused solely on products related to COVID-19; the channels that are already in place could nonetheless be expanded into a permanent international procurement facility for vaccines targeting multiple types of diseases caused by emerging pathogens. The Pandemic Treaty, currently under negotiation, could serve

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as the catalyst for such an expansion. Alternatively, the Treaty could mandate the creation of a new structure. Other *ad hoc* mechanisms, such as a resolution from the World Health Assembly or a call from a national government interested in serving as a convener for the initial negotiations, could also serve as the triggers for the creation of this structure.

Another critical feature of the multi-modal system is the inclusion of a threshold agreement on how much vaccine product should be committed to it, and how to ensure that those commitments become effective once transnational demand for a particular vaccine arises.

With regard to commitments of vaccine doses, a formula can be adopted during the initial negotiations to be applied once production of the vaccine begins. For instance, that formula may consist of a percentage of doses produced in the country making the commitment. Other approaches are possible. Recall, for instance, that COVAX sought initial commitments that would generate enough vaccine doses for participating countries to vaccinate at least 20 percent of their eligible populations.[71] In the *ex ante* approach proposed here, the percentage negotiated with reference to a future pandemic or epidemic could similarly target patient needs or other criteria. This approach would have the disadvantage of requiring some degree of framing (how to define "need for a vaccine" and when to measure it) and calculations to be performed with the pandemic or epidemic already under way. Basing the formula on definite percentage of supply would provide a simpler and more straightforward approach.

It is nonetheless possible that parties agreeing *ex ante* to both the formula and the allocative system will nonetheless default at the time of performance. While it is possible to conceptualize mechanisms to coerce performance — ranging from monetary sanctions to retaliatory measures — these seem difficult to implement, particularly in the context of a system aimed at facilitating compromise between parties that have not bargained on these issues before. This constitutes a limitation of the proposal, although it might be mitigated to some extent by the reputational losses that countries backing out of their pre-established commitments would suffer in the international community. Moreover, this limitation would hopefully be further lessened by the lessons (re)learned throughout the COVID-19 pandemic with regard to the benefits of concerted action and transnational solidarity in addressing both the public health and the extra-public dimensions of pandemics and epidemics.[72]

Finally, the proposal faces other limitations, including the fact that some of the allocative criteria rely on considerations extraneous to public health; the fact that the proposal will not eliminate bilateralism, but likely co-exist with it; and the fact that its negotiation and implementation depend on achieving a meaningful level of international consensus at a time of renewed challenges to the international order.

Even though it faces these limitations, a multi-modal system can provide a more flexible and politically viable alternative to current approaches to lessening the inequitable effects produced by the current bi-modal framework relying primarily on bilateralism and secondarily on (limited) international procurement. Its tailorable and bargainable nature allows for experimentation, with the *ex ante* approach removing some of the market pressures that arise during pandemics and epidemics. As such, it is a tool worth considering by those seeking to counter the exclusionary effects — and their disproportionate toll on populations in lower-income countries — generated under the *status quo*.

Note

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