COVID-19 Vaccine Allocation

SUMMARY

Vaccines for COVID-19 will be scarce while production capacity is low and global demand is high. All populations will need to determine how to allocate limited vaccine doses to maximize their impact. Here we describe how PriorityVax, a tool to support transparent and accountable decision-making, can support ethical and sustainable allocation recommendations.

BACKGROUND

COVID-19 has wrought enormous costs, measured in lives, livelihoods and economic disruption. With no clear treatment to date, there has been an unparalleled effort to develop vaccines, which are seen as a way to return to some semblance of pre-pandemic ‘normality’. The speed of vaccine development has been unprecedented, but even when they are deemed safe and ready for widespread use, vaccines shall be in short supply given production capacity and global demand. As with any scare resource, choices are needed to efficiently allocate vaccines to maximize their positive impact.

These allocation decisions are multi-factorial and not without complexity. Not only do vaccines have to be distributed to those in greatest need, but they might also be used to break transmission and preserve important societal functions. With a finite supply, there will be those who need to be prioritized, but equally by definition, some groups will have to wait. As a politically and ethically sensitive challenge, there is an urgent need for transparent and evidence-informed decision-making processes.

PriorityVax is a tool that was designed to support decision-making about the identification of health priorities, in particular the prioritization of different vaccines. To date, PriorityVax has been used to either select between vaccines addressing different diseases or to select between vaccine products for the same disease. What has become apparent, however, is that the same approach can be taken to identify and prioritize groups of individuals based on their risks and needs for a vaccine couched within the local epidemiological and social context of countries and communities.

PriorityVax is not prescriptive; it is designed as an open-ended tool to support your deliberative decision-making processes and align with your values. The steps of defining your decision criteria and giving them explicit weights will help to make your process transparent. Then identifying groups and scoring each against your pre-defined drivers will help to make your process auditable. With PriorityVax, it is easier to articulate how the decision was reached and gain buy-in from other stakeholders.

ETHICAL FRAMEWORK

Three principles are common to multiple allocation frameworks¹ that have been advanced to consider COVID19 vaccines. All are embedded within an ethical framework: utility – maximizing the benefit of the vaccine, while minimizing the harm of the disease; equity – using vaccines to reduce health disparities; and

**fairness** - if all else were the same (e.g. risk and consequence of infection), then allocation is at random (e.g. a lottery) as every individual is equal. Other issues that are emphasized include the need to have a transparent and evidence-informed process (legitimacy) and to prioritize the most vulnerable, for example because they are disadvantaged or marginalized.

An ethical framework lays out the key principles of allocation, but it does not of itself identify either criteria for a decision, i.e. the objectives to operationalize the ethical framework, or the groups themselves. For both of those, you will need to think about your own context and needs. There have been efforts to allocate scarce vaccines before that can be used as illustration or inspiration on how you might articulate why particular groups are given greater or lesser urgency. For example, identifying actionable strategies by defining utility in terms of clinical cases, transmission or morbidity and mortality.

We have taken the WHO ethical framework as a well-articulated exemplar. Beyond the components articulating issues of inter-national equity, this framework is very similar to others that have been proposed for intra-national vaccine allocation.

**OPERATIONALIZING THE FRAMEWORK**

Operationalizing an ethical framework means that the ethical ideals are interpreted as strategic objectives. From these objectives, you can identify your criteria for scoring groups and to identify the groups themselves. For example, the primary aim may be to reduce mortality and therefore groups with the highest risk of dying should be prioritized for vaccination. Therapeutics might then be reserved for less severe infections. Alternatively, if the aim is to preserve critical health services, vaccines or diagnostic testing might be prioritized for workers in those roles.

It is envisaged that countries will identify groups for prioritization based on the best available and latest evidence (epidemiological and otherwise) and the values best aligned with their populations.

The WHO, and others, recommend classifying groups into tiers, where each tier represents groups of similar risk profiles. In PriorityVax this is more of an emergent property of how groups are scored – if populations are at similar risk and their vaccination will meet the same objectives, then they ought to achieve comparable scores. The more practical advantage of tiered vaccine release is that each tier might correspond to a different number of doses that are needed. As more doses become available, additional tiers can be vaccinated.

As a simplified prioritization, The WHO suggest the following – noting that this is not prescriptive and the decision is left to each country – that the primary goal is to simultaneously reduce mortality and protect health services: first, vaccinate front-line staff in health and social care; second, vaccinate based on risk of mortality (defined by age and underlying co-morbidities). The WHO estimate that these two groups will total approximately 3% of the population.

In more detailed examples, the WHO propose identifying groups in three categories, which can be stratified by five criteria:

- Those at high risk of mortality
- Those at high risk of infection
- Those who are transmission risks
- Those who will suffer most from disruption
- Those who provide a critical service

These criteria describe risks that are inherent in the functional role of an individual and that cannot be

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otherwise mitigated. For example, critical administrators are recommended to be a very narrow definition as only those necessary to running critical services. Risk to others might be offset by physical distancing (such as working remotely or physical distancing).

The exact identification of those who fall into any one category should be defined at country-level. The WHO propose using occupational role\(^2\), whereas others have argued that classification should be based on function rather than profession\(^1\). Those who qualify for multiple categories would be moved to the maximum priority group.

For the purposes of demonstration in this document, we use the five criteria above to show how a process might be built around these proposed groups within the PriorityVax platform. The selection of both groups and criteria is for you to identify.

**USING PriorityVax**

In PriorityVax, each population group needs to be coded in the ‘vaccine’ category—because this is what PriorityVax was designed to prioritize between. The decision criteria (for example, the risk of mortality or transmission above) is coded as an ‘attribute’. The attributes are next weighted (the sum of the weights is 100%) based on their relative importance to your context.

*Left: example of differentially weighting criteria.*

In your context, for example, there might be relatively few deaths but quite a high risk of social disruption; equally, you might consider protecting the health system a higher priority than trying to block transmission in the population at large. These are decisions you shall have to make and it may be that you consider all these attributes equally important. In PriorityVax you can save your analysis and revisit these values to explore the sensitivity of the prioritization to these subjective weights. This can be done in real-time as you move through your initial process or at a later stage when vaccine supply or disease epidemiology may significantly change.

Each group is scored against each attribute using the best available evidence and, most likely given the uncertainties around COVID-19, expert judgement. This is extremely important because this will require considerable thought and discussion, perhaps consultation with experts outside the immediate committee. For example, following the WHO framework above, you will need to input a score for the risk of mortality for each population; some will score higher, by age for instance, and others lower.
EXAMPLE of PriorityVax

We have taken the five attributes listed above and used these to score each of ten groups, inspired by other allocation frameworks. We used a five-point scale to represent a very low to very high qualitative scale for each attribute.

The attributes themselves were weighted (see figure above) to put the greatest emphasis on first, reducing the risk of mortality and second, the risk of transmission.

Below: Example values for each group against each criteria on a scale of 0 to 4.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mortality</th>
<th>Transmission</th>
<th>Critical Service</th>
<th>Disruption</th>
<th>Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults &gt;65y</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Unable to distance</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Underlying co-morbidities</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Health workers</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Adults &gt;50y</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Risk through work</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Emergency responders</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>School children &amp; staff</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Critical frontline workers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Critical infrastructure</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Right: The resultant PriorityVax scores for the ten example groups (table above) and weighted criteria (figure above). Longer bars indicate higher priority based on the sum of the product of scores assigned and the weighted criteria.
Vaccine doses for x% of the population

<table>
<thead>
<tr>
<th>1-10%</th>
<th>11-20%</th>
<th>21-50%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Widespread Transmission</strong></td>
<td><strong>Localized Transmission</strong></td>
<td><strong>No Current Transmission</strong></td>
</tr>
<tr>
<td>Health workers at high risk of infection and transmission</td>
<td>Health workers at high risk of infection and transmission</td>
<td>Health workers at high risk of infection and transmission</td>
</tr>
<tr>
<td>Older adults</td>
<td>Older adults</td>
<td>Essential travellers at risk of returning with infection</td>
</tr>
<tr>
<td>Emergency reserve</td>
<td>Co-morbidities</td>
<td><strong>Border protection staff</strong></td>
</tr>
<tr>
<td>Age groups at high risk of transmitting</td>
<td>Groups at significant risk of severe disease or death</td>
<td>Emergency reserve</td>
</tr>
</tbody>
</table>

Key

**Well-being**
- Reduce deaths and disease burden
- Reduce societal & economic disruption
- Protect essential services (incl health)

**Equal respect**
- Treat all groups equally
- Equal opportunity for vaccination

**Equity**
- Treat all groups equally
- Access socially disadvantaged

**Reciprocity**
- Protect workers put at additional risk

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Left: Suggested WHO 'road map' of vaccine allocation, linking ethical objectives (colors) to priority groups given both the availability of vaccine doses (columns) and transmission context (rows).

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