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Rationing of influenza vaccine during a pandemic: Ethical analyses

Richard Kent Zimmerman [a,b,*]

[a] *Department of Family Medicine and Clinical Epidemiology, University of Pittsburgh School of Medicine, 35l8 Fifth Avenue, Pittsburgh, PA 15261, United States*
[b] *Department of Behavioral and Community Health Sciences, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA, United States*

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Abstract

Rationing of scarce vaccine supplies will likely be required when the next pandemic occurs, raising the questions about how to ration and upon what principles. Because influenza pandemics have differing mortality patterns, such as the 1918 pandemic's "W" shaped curve that effected healthy young adults, the particular pattern should inform rationing. Competing ethical principles for vaccine rationing are utilitarianism and egalitarianism. Vaccine manufacturers and essential healthcare workers can be justified with either principle. Utilitarian principles of choosing based on social worth or those in whom vaccination is most likely to medically succeed raise substantial justice issues. Egalitarian principles of medical neediness and random chance avoid justice concerns and are proposed. A framework that uses multiple principles to address influenza vaccine rationing in light of a shortage is recommended.

Keywords: Influenza vaccine; Rationing; Vaccine shortage; Pandemic influenza

Influenza pandemics are devastating with millions of deaths worldwide. For instance, in the pandemic of 1918–1919, an estimated 20–40 million deaths occurred worldwide with 500,000 or more in the United States alone [1]. The H5N1 strain that is highly pathogenic in birds and is spreading rapidly leads to concerns about preparations for the next pandemic. Unfortunately, vaccine for humans for the next pandemic is likely to be scarce at least initially and rationing will be required. How should such a vaccine be rationed? I propose a framework that considers the epidemiology of influenza; suffering due to complications; differing pandemic mortality patterns, given the historical differences between pandemics; efficacy of inactivated influenza vaccines, and competing ethical theories of utilitarianism and egalitarianism.

1. Epidemiology of influenza

Influenza surface antigens periodically change, leading to antigenic shift, a major change, and drift, minor changes due to point mutations. Antigenic *shift* is a major change in the subtypes and occurs in influenza type A only. The result of a shift is a new strain to which there is little or no prior immunity. Circulation of this strain can lead to a pandemic, which is characterized by severe, rapidly progressive outbreaks that involve all parts of the world with high attack rates occurring in all age groups. For example, among those who were documented to have symptomatic influenza A in years before the H2N2 pandemic of 1957, few (5.6%) adults in contrast to 55% of children contracted pandemic H2N2, suggesting heterosubtypic immunity [2]. A reassortment with an avian influenza virus occurred with the 1957 and 1968 pandemics [3]. Swine may have been the mixing vessel for such reassortments.

* Tel.: +1 412 383 2377; fax: +1 412 383 2306.
E-mail address: zimmer@pitt.edu.
URL: http://www.pitt.edu/~familymd/immunization.

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1.1. Transmissibility

Because pandemics occur only several times per century, reviews of pandemic influenza often involve discussions of inter-pandemic influenza, including transmission in healthcare facilities.

Inter-pandemic human influenza is extremely contagious and is transmitted from person to person, usually by the airborne route. Consequently, persons in semi-closed or crowded environments, such as students, prisoners, and residents of nursing homes, are at high risk of exposure. In nursing homes, up to 60% of patients can develop disease [4,5], and of those, 30% can die [6]. Infected persons are most contagious during the period of peak symptoms. In adults, the communicability is highest from 1 day before the onset of clinical illness to 5 days thereafter, whereas young children can shed virus for up to 6 days before the onset of symptoms. The incubation period is usually 2 days (range, 1–4 days).

Healthcare-associated influenza transmission has been documented in many settings, with healthcare workers (HCWs) having a role in the transmission chain [7]. Healthcare-associated influenza outbreaks have resulted in increased patient morbidity and mortality [7].

Due to the rapidity of spread, the world may have little time to prepare vaccine for the first wave, since the pandemics of the 1889–1890 and 1899–1900, during the time of steamship travel, crossed the Atlantic to the US within 2 months of activity in Europe [3]. Pandemics historically have occurred in two to three waves; hence, time may be available after the first wave to produce vaccine. The serial interval, the time from infection of one person to their contacts, varies by study, including figures of 2.6 days [8] to about 4 days [9]. Estimates of the basic reproduction number, R_0, which is the average number of secondary cases generated by a typical primary case in a susceptible population, varies by study and includes values of 1.68–20, with the claim that for most estimates of the serial interval, the R_0 would be 2–3 for the 1918 pandemic [8,10].

The first waves of pandemics have not occurred until schools were in session, with the illness attack rate being high in children. The highest age specific attack rates in 1918 were among 5–9 and 10–14 year olds, respectively, with attack rates of 39 and 38%, and in 1957 among 10–14 and 15–19 year olds, respectively, at 52 and 54% [3]. In the first wave of a pandemic, between 25 and 50% of all persons are typically infected [3]. The severity of illness may be responsible for limiting spread.

2. Complications of influenza and suffering due to pneumonia

Complications of influenza include secondary bacterial pneumonia, worsening of chronic respiratory and cardiac diseases, sinusitis, otitis media, primary viral pneumonia (uncommon), myositis, encephalopathy and, in children, Reye's syndrome. In the 1918 pandemic, an acute adult respiratory distress syndrome (ARDS) presentation was common and was likely due to an inflammatory reaction, including a cytokine storm. This is similar to the pathogenesis seen in the recent, albeit small, number of human deaths due to H5N1.

A discussion of the ethics of vaccine rationing leads to a review of suffering due to pneumonia, particularly in the elderly, as the suffering due to ARDS is fairly obvious. In a study of 1812 patients with pneumonia, 17 of 18 symptoms significantly decreased in prevalence with age. While some reductions in prevalence of symptoms were clinically meaningless (e.g., cough in 90% of young persons versus 84% of the elderly), others were meaningfully different (e.g., pleuritic chest pain in 60% of young persons versus 31% of the elderly) [11]. However, duration of symptoms was significantly longer in the elderly (e.g., dyspnea lasted a median of 3 days in young persons compared to 5 days in the elderly and sputum production was a median of 4 days in young persons, compared to 6.5 days in the elderly) [11]. Furthermore, tachypnea significantly increased from 36 to 65% with age [11]. The symptom score for documented *S. pneumoniae* was significantly higher in those <65 years than those ≥65 and this organism is known to complicate influenza infection [11]. Elderly patients with pneumonia are more likely to develop bacteremia and complications such as empyema and meningitis [12]. Among those with dementia, assessment of discomfort by rating scales shows higher rates of pain in pneumonia patients prior to death than among patients who died due to other causes [13]. This study also showed that discomfort was higher in pneumonia patients without antibiotics than those who received antibiotics. They concluded, 'from the perspective of intensity of suffering, we are far from calling pneumonia "the demented patient's friend"' [13].

3. Pandemic mortality patterns

Mortality patterns vary by pandemic. The fatality rate by age from influenza in the 1957 and 1968 pandemics was "U" shaped, similar to the "J" shape of mortality curves for inter-pandemic influenza. Estimates of US deaths in the 1957 pandemic are 69,800 and in the 1968 pandemic are 33,800 [1]. The majority of deaths were in the elderly [14–16] and among those with high risk conditions; the highest death rates were among those elderly persons with high risk conditions, particularly if the person has two high risk conditions [16]. Excess pneumonia and influenza hospitalization rates were higher in all age groups, with those with high risk conditions and the elderly having the highest excess rates [14].

In contrast to the 1957 and 1968 pandemics, the 1918 pandemic revealed a "W" pattern with a high rate of deaths also among young adults aged 20–40 years [3]. Although it is tempting to ascribe this to crowding of soldiers in World War 1, which certainly contributed to spread, the fatalities in young adults in the US who remained at home were higher [3]. In the 1918–1920 pandemic, an average of 225,000

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excess deaths occurred in the US for each year of the 3-year pandemic period [3]. Death in adults in 1918 was largely due to a virus-induced immune responses, namely a cytokine storm, which resulted in an acute respiratory distress syndrome (ARDS) [17]. Over half of those who died in the 1918 pandemic were 18–40 years of age and most were healthy [17]. The mortality rate was about 1 in 100 among persons aged 20–39 years.

The mortality pattern of the next pandemic is unknown but data from the avian H5N1 cases in humans are available and suggest an ARDS picture. Published mortality rates range from 33 to 100%, although certainly this is biased by presentation of the more severe cases to medical facilities [18]. Mortality due to avian H5N1 influenza in Thailand is higher at 90% among children <15 years of age than adults among whom mortality was 57% [19]. Among hospitalized persons with H5N1 infection, respiratory failure has been noted in 44–100% [18]. The process has been a primary viral pneumonia, usually without bacterial suprainfection, that progresses to ARDS [18]. Plasma levels of inflammatory mediators including interferon and cytokines are higher among those who died than among those who survived [18].

4. Inactivated influenza vaccines

Two types of influenza vaccines are currently licensed in the US: trivalent inactivated influenza vaccine (TIV) and live attenuated influenza vaccine (LAIV). The TIV is composed of subvirion or purified surface antigen preparations, which have lower rates of side effects than older whole cell preparations. Because the vast majority of current vaccine supplies are inactivated and current pandemic preparations are based on inactivated vaccine, my review will focus on inactivated vaccines, although LAIV could have advantages, particularly in children.

Unfortunately, conventional inactivated vaccines may be less effective against pandemic viruses [20], requiring more quantity of antigen and perhaps two doses for everyone. Split virus vaccines are less immunogenic in persons who have not been primed through previous vaccination or infection with the same or related antigens, thus two doses may be needed [1]. Efficacy may vary modestly by age, being lower in young children and the elderly; however, head-to-head comparisons are often lacking for pandemic influenza vaccines and the differences between ages for inter-pandemic vaccine are modest (Table 1). As a consultant to the CDC for vaccine prioritization panels, my observations of the discussions suggest that the assembled experts did not consider the small differences in efficacy by age to merit any policy differences by age.

5. Ethical analyses

5.1. Competing ethical approaches: utilitarianism versus egalitarianism

Consensus is lacking on distributive principles for healthcare [21]. In a classic work dealing with just rationing of scarce medical resources, Gerald Winslow contrasts the strengths and weaknesses of utilitarianism and egalitarianism [22]. Winslow offers a framework which is useful for considering the rationing of influenza vaccine in light of a pandemic.

5.2. Utilitarianism and utilitarian principles for rationing

Utilitarianism looks at the rightness or wrongness of a decision based on its consequences and resultant strategies that either maximize happiness or minimize unpleasantness. Utilitarianism or the broader perspective of consequentialism has commonly been used in triage situations, including military triage during wartime, and has the benefit of weighing perceived consequences in order to rank options. Utilitarianism was once highly popular in Western thought; however, it has lost popularity due to several weaknesses, including its infamous use as a defense by Nazi physicians at the war crimes trials [23]. Other weaknesses include difficulty in predicting which choices produce the most happiness; concern that utilitarianism requires injustice against innocent persons and harms conscience (e.g., forced to choose the "lesser of evils"); and its potential to justify injustice to minorities to satisfy the majority [24–27]. A recent study of preferences for health-care rationing found a split between procedure-based rationing and anti-consequentialism and concluded that consequentialism is insufficient for public health decision-making [28].

Table 1
Inactivated influenza vaccine efficacy when antigen match is good by outcome and age

Population	Outcome	Efficacy/effectiveness (%)
Preschool-aged children	Laboratory confirmed ILI	44–67
School-aged children	Laboratory confirmed ILI	56–76
Healthy adults <65 years old	Laboratory confirmed ILI	70–90
Community based elderly	Hospitalization for P&I	30–70
Community based elderly	Laboratory confirmed ILI	50–60
Institutionalized elderly	ILI	30–40
Institutionalized elderly	Hospitalization for P&I	48–60
Institutionalized elderly	Influenza-related Death	68–80

Derived from refs. [48–50]. ILI: influenza-like illness.

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Utilitarian principles, based on Winslow's work as applied to rationing, include priority to those (1) in whom treatment has the highest success, (2) who are most useful, (3) who require proportionally small amounts of resources, and (4) who have greatest social worth [22]. I will discuss each in turn, followed by a few related criteria.

Priority to those in whom treatment has the highest probability of success certainly seems logical. At first glance, as applied to influenza vaccine, this is likely to include adolescents through middle age groups as long as they do not have severely immunocompromising conditions. However, other issues are also related to the probability of responding to a vaccine. For instance, efficacy may be somewhat higher in those who have healthy habits such as moderation in alcohol consumption and good nutrition and who are compliant, as two doses are likely to be needed. Such factors may also be related to social worth and socioeconomic status and the greater the number of such factors that are considered, the greater the concern for injustice [22]. Other concerns are that allowing clinicians to determine the highest probability of success raises concerns about transparency and about equitable justice, as clinicians might apply the criteria differently, due in part to both patient and clinician heterogeneity [29]. Furthermore, sociologists have noted several other problematic issues, including the highly "particularistic" nature of clinical decisions, the challenges that clinicians face in recognizing the collective consequences of individual patient decisions, and the difficulty clinicians have in imposing limits on patient treatments [30]. All of these issues point to the difficulties in prioritizing those who have the highest likelihood of success.

Priority to those who are most useful during a pandemic is also logical as critical personnel are needed in the vaccine manufacturing process and in healthcare institutions to assist the great number who would be ill in a pandemic [31]. Arguments for prioritization of healthcare workers (HCWs) by the Society for Healthcare Epidemiology of America include risk of transmission to patients and other HCWs, decreasing absenteeism of essential HCWs during outbreaks when hospitals are burdened by patient load, protecting HCWs who have conditions that place them at risk for influenza complications, and protecting high risk household and personal contacts of HCWs [7]. A problem develops in defining the most useful personnel as a myriad of occupations from undertakers to news broadcasters to food supply workers would claim to be a part of critical infrastructure. Of course, historical military triage examples include using scarce antibiotics for gonorrhea treatment of flight crews of airplanes. Non-utilitarian versions of this principle can also be given; for instance, healthcare workers benefit others and may improve the prospects of those who are the sickest.

Priority to those who require proportionally smaller amounts of resources seems logical. Data of partial, inactivated influenza vaccine doses during inter-pandemic periods for healthy, young and middle age adults have been conducted that show a generally good robust response in most individuals [32,33]. However, such data on pandemic strains may not be available on short notice during a pandemic and the substantial shift in strains does not lead to confidence that the heterotypic immune response seen during inter-pandemic periods applies during a pandemic.

A related idea is to conserve resources by ring vaccination, limiting vaccination to those in close contact with initial cases [31]. Both utilitarian and egalitarian arguments could be made for this. Ring vaccination has been successful with smallpox but is problematic for influenza as viral shedding starts before symptoms, particularly with children and because of the rapidity of travel in the 21st century.

Priority to those of greatest social worth has occurred in the past but raises substantial concerns about justice. Intangible personal characteristics such as generosity, charisma, and creativity, cannot easily be quantified and may seem arbitrary [34]. Contributions of a person may not be really known until after they have died, as seen by the popularity of some composers and artists after death but not during their lifetimes. In previous years when dialysis facilities were quite limited, patients involved in those community activities valued most by members of the selection committee were reported to be most likely to be chosen for treatment. Treatment decisions made on basis of the number of dependents or the amount of some type of productivity values some members of society more than others [35]. Finally, a social worth criterion can discriminate against several groups, including racial minorities, the poor, and the disabled, who typically rank low on social value scales [34].

A few comments are needed about a potential quality of life criterion. Quality of life assessments can be arbitrary and relative. When people attempt to judge other's quality of life based on observable issues, they often differ from the patient's own experience of their lives, raising doubts about the validity of such judgments [34]. For example, physicians rate the quality of life of inpatients significantly lower than did the patients themselves [36]. A second study of physician perceptions of the patient's quality of life demonstrated marked variability between physicians [37]. Quality of life assessments can discriminate against several groups; for instance, persons may rate the quality of life of people of dissimilar race, gender or SES as lower than their own. Empowering some to judge the value of others could be dangerous to the weakest members of society, particularly the poor [34].

Some utilitarians suggest an age criteria or length of life criterion which is objective, simple, and on the surface, appears equitable. However, it has multiple limitations. First, although age is objective, that does not mean that it is appropriate; for example, weight too is objective but irrelevant to vaccination (unless related to a severely immunocompromising condition) [34]. Second, although this criterion appears equitable on the surface, it actually demeans those who have gone beyond it (e.g., the elderly) and suggests that they have accomplished all that they can, once they reach that point. Such suggestions may be charged as paternalistic. One's right to life, liberty and pursuit of happiness does not diminish with

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age. Third, an age criterion may miss important data about the epidemiology of and suffering from pneumonia, if that is the primary means of death, as previously discussed. One study sought to answer the question "Is pneumonia a terminal event for elderly patients who would otherwise die over the succeeding months from underlying, chronic illnesses?" [38]. In a proportional hazards model, 2-year mortality was significantly associated with underlying medical illnesses and hematocrit <35%, but not with age [38]. The authors report that the severity of underlying illness simply "overwhelms" the effect of age [38]. Fourth, vaccination is immunogenic in most elderly persons and immunogenicity is driven more by underlying medical conditions than by age. A variation of the age limit criterion is a criterion based on estimated length of life remaining which favors the young instead of treating each person equally, and in essence devalues those with lesser time remaining [35].

5.3. Egalitarianism and egalitarian principles for rationing

Egalitarianism is based on the maintenance and restoration of equality and proposes that the persons have essentially equal rights to have their needs met [22]. Thus, justice consists of distribution according to need. All lives are counted as equals. Weaknesses of pure egalitarianism include difficulty in prioritizing vaccine to critical infrastructure without unjustly valuing some more than others and the *perception* that some will be allotted the resource who have less to offer or gain than others who would not have the chance to receive the resource. Egalitarianism is accused of being the easy way out that will not address the hard choices when medical resources are scarce.

Egalitarian principles, based on Winslow's work as applied to rationing, include priority to those who (1) are the medically neediest, (2) are the generally neediest, (3) come first, or (4) are selected by chance [22]. I will discuss each in turn, followed by a review of a medical benefit criterion.

Priority given to the medically neediest is the essence of the egalitarian approach to social justice [22]. This gives priority to the most ill, which is inefficient by a productivity standard. As applied to the most recent pandemics, those most likely to die are the old, young children, and those with underlying disease, who then would be prioritized for vaccination [31]. Of course, young adults would also be a priority if the "W" mortality pattern of the 1918 pandemic occurred. In any case, the number prioritized under such a scheme would be quite large and further prioritization using other principles would be needed. This criterion was used in the recent US influenza vaccine shortage [39,40].

Priority to the most helpless is based in part on the principle of compensatory justice [22]. Groups that this prioritizes include children and the handicapped. Other groups that this prioritizes are those deprived of advantages by past social injustice. Unfortunately, these criteria may be difficult to apply, particularly during the chaotic periods of a pandemic.

Priority to those who come first has long been recognized as egalitarian, being based on equality of opportunity and some equate this with a random process [22]. However, those with good connections and better access to information and transportation are more likely to come first and these factors are related to social and economic status. Thus, "first-come" is problematic for just pandemic planning.

Priority to those selected by chance in a lottery is totally impartial. The lives of each person are given the same weight as any others [22]. This removes concerns that humans are ill-equipped to decide whom should live when all cannot and removes judgments about relative values between people. It is criticized for lack of rational prioritization and being an easy method to avoid hard decisions.

Another egalitarian principle which is not part of Winslow's scheme is a medical benefit criterion which specifies that those who *lack* a reasonable likelihood of receiving significant benefit from treatment are excluded from treatment on medical grounds [34]. In this setting, "significant" refers to the smallest amount that can reasonably be considered important. For example, a severely immunocompromised person within a few weeks of death would not qualify as he or she is unlikely to respond to vaccination. The individual might not have time to respond before death, as it takes about 2 weeks for the immune system to respond to inactivated influenza vaccine; and the vaccinated person would have minimal time to enjoy protection if it occurred. This criterion gives equal regards for all persons and is consistent with policy recommendations to withhold cancer screening in those without a sufficient life expectancy to realize a benefit.

5.4. Both utilitarian and egalitarian principles

Two principles seem to straddle the utilitarian/egalitarian divide: usefulness, which was discussed above but is listed under utilitarian principles in Winslow's text [22], and reducing transmission, which I discuss below.

Benefit to reducing transmission straddles the utilitarian and egalitarian perspectives. School-aged children play a role in the transmission of influenza and, based in part on mathematical models, have been proposed as a priority group for vaccination [41]. Although most experts whom I know agree that children are important in transmission, concerns about the data limitations exist. These include difficulties in measuring the amount of actual transmission during pandemics that is due to children in various settings and the contagiousness of influenza in other groups and thus, have not led to widespread adoption of this strategy. This principle was considered in the recent US influenza vaccine shortage but other principles prevailed [40].

5.5. Applying multiple ethical principles to vaccine rationing

Multiple principles will need to be applied in many rationing situations due to the complexities of the decisions.

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A key feature is a fair, transparent, and legitimate process [21]. John Rawls suggests that a diverse group of persons who were unaware of his or her own status, sex, race, social position, and economic condition would choose just principles because they could not choose principles that would favor each one's own position [42]. Behind such a Rawlsian veil of ignorance, the presumption of equality would be stressed and death would be avoided [22,42]. Rawls is seen as favoring a lottery when equally strong claims can be made for a resource – among medically eligible candidates – and indeed this was done by the British Ministry of Health historically during a time when polio vaccine was scarce [43]. Rawls believed that inequalities are allowed only when they benefit everyone and benefit, in particular, the least advantaged. Thus, a healthcare worker prioritization for vaccine might be argued on this basis due to the need to care for the sick.

For the situation of a scarce number of artificial hearts, Winslow supports medical neediness and random selection, qualified if needed by medical success, conservation (smaller amounts), and "first-come" [22]. For triage in a disaster such as an earthquake, he supports medical neediness and "first-come", supplemented by medical success, usefulness, and conservation.

My evaluative summary of the ethical principles for rationing influenza vaccine is given in Table 2. On the basis of providing more vaccine to save more lives, vaccine manufacturers would be a top priority, followed by HCWs as they could save lives by their care. Then, I would apply a medical benefit criterion. In the setting of a "U" shaped mortality curve, I would apply medical neediness and then select by random lottery. In the setting of a "W" shaped morality curve, the medical neediness criterion may be difficult to apply so a lottery would follow medical benefit. I see the epidemiology and mortality patterns of the particular pandemic as supplying important scientific facts to guide the application of ethical principles.

5.6. Sufficient risk assessment of influenza pandemic threats

Finally, one important ethics point is sufficient risk assessment of influenza outbreaks and potential pandemic threats. In the 1976 swine influenza episode, the US government pushed a massive vaccination program after a small outbreak of H1N1 swine influenza among military personnel at Fort Dix, New Jersey. In light of previous pandemics, stockpiling vaccine in 1976 was probably prudent [1]. However, the outbreak did not spread and an adverse reaction, Guillian–Barre syndrome, was associated with the swine influenza vaccine of 1976 [44]. This reaction has led to distrust and lingering concerns about influenza vaccine safety. Indeed, inaccurate public perceptions of vaccine risk based on media and Internet portrayals of alleged reactions threaten

Table 2
Ethical appropriateness of influenza vaccine rationing principles in light of pandemic influenza and a severe vaccine shortage, by mortality pattern and by type of ethical principles (utilitarian, egalitarian, or both)

Principle for rationing	Ethical appropriateness by pandemic mortality pattern		
	Appropriateness by mortality pattern		Comment
	Deaths by pneumonia and cardiorespiratory complications predominate in young and old	Deaths from adult respiratory distress syndrome predominate, including young adults	
Utilitarian principles			
Medical success	Secondary, may not be scientifically well known	Secondary, may not be scientifically well known	Excludes severely immunocompromised
Most useful in a pandemic	Yes, vaccine manufacturers and healthcare workers[a]	Yes, vaccine manufacturers and healthcare workers[a]	Critical workers only
Small vaccine dose	Secondary, depends on details, may not be scientifically known	Secondary, depends on details, may not be scientifically known	Option is to offer small dose to all, knowing young and old somewhat less likely to respond
Social value	No	No	
Quality of life	No	No	
Age (e.g., exclude the elderly)	No	No	
Egalitarian principles			
Medical neediness	Yes, primary prioritizes young, old, and those with underlying illness	Yes, primary but no prioritization possible	
Most helpless	No	No	
First-come	Questionable	Questionable	
Random chance	Yes, primary	Yes, primary	
Medical benefit	Yes, primary	Yes, primary	
Both principles			
Reduce transmission	May not be scientifically known but potential	May not be scientifically known but potential	Live attenuated vaccine, if available, might be useful

[a] Egalitarian principles can also be argued for this principle but Winslow lists as utilitarian [22].

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vaccination programs [45–47]. Thus, in retrospect, wider scientific review might have delayed release of the vaccine to the public pending evidence of wider transmission [1]. Herein lies a tension between quick response and wider review, with the potential to err on either side.

6. Limitations

Several limitations to this analysis should be listed. First, the epidemiology and mortality patterns of the next pandemic, including the specifics of the role of children, are not known and would affect conclusions. Second, this analysis does not account for widespread use of LAIV, particularly among children. If pandemic LAIV were available in large amounts for children and if efficacious in children for herd protection of the community, then priorities might change; however, limitations of data and availability prevent conclusions on this today. Third, competing ethical theories clash; I have tried to respectfully merge scientific data with aspects of utilitarianism and of egalitarianism, but I suspect proponents of each of these competing theories would fully favor their own and I admit to preferring the egalitarian perspective.

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