

A Framework for Respiratory Ethics

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The Covid-19 pandemic raises the need for an ethical framework addressing the unique challenges of airborne infectious disease. In particular, are you ethically obliged to wear a face mask? If so, why and when? The Respiratory Ethics Framework (REF) herein derives answers thereto from ethical norms. Always covering coughs and sneezes just in case you might be infectious is an ethical norm. But if you *are* infectious with an airborne illness, you are probably spreading germs even with every breath and vocalization. Therefore, given that respiratory covering should be done to prevent spreading germs, you should wear a mask if you believe you are infectious because it provides covering while breathing and vocalizing. REF is grounded in the classical *harm principle* and the Golden Rule. Why should we avoid spreading germs to others? Because germs can cause bodily physical harm and we should act to prevent causing such harm to others just as we would wish that they act to prevent causing such harm to us. Under REF your obligation to wear a mask is a function of your belief about your likelihood of infecting others or is a binary function of your beliefs about infectiousness and vulnerabilities. These ethical obligations are visually mapped and presented within simple computational models.

Contemporary Context

As the Covid-19 pandemic swept the globe in 2020, respiratory hygiene became a centerpiece of daily life because the risk of harm from respiratory effluent increased with the novel SARS-2 virus. Given the ethical norm that harming others is impermissible, the ethical significance of respiratory hygiene increased correspondingly. Advocates of respiratory hygiene therefore invoked ethical themes. Appealing to the ethics of personal rights, New York Governor Andrew Cuomo told those who would refuse to wear a face mask, “You don’t have a right to infect me.” [1] Invoking ethics of reciprocity and solidarity, a popular slogan asserted, “My mask protects you, your mask protects me.” [2] Or as the Oklahoma Department of Health phrased it: “I wear my mask to protect you. Will you wear yours to protect me?” [3] In other words, wear a mask or commit the ethical faux pas of failing to reciprocate in kind.

Such ethical appeals were not universally persuasive. Early in 2020 opponents of respiratory hygiene mandates began galvanizing public opinion. [4-7] They claimed face masks will not work, despite evidence of their efficacy against the SARS-1 virus many years prior. [8] They also claimed that mask mandates are unethical because they violate individual liberty. [9,10] Yet a basic tenant of liberty is that it is not a license to harm to others. As the libertarian philosopher John Stuart Mill put it: “the only purpose for which power can be rightly exercised over any member of a civilized community, against his will, is to prevent harm to others.” [11] One way to prevent harm to others is to avoid infecting them with harmful pathogens. Public-health ethics likewise recognizes that personal liberty must be balanced against other ethical principles such as *nonmaleficence*, [12] especially during a pandemic. [13]

While appeals to ethics are often invoked in defense of respiratory hygiene, little attention is given to respiratory hygiene ethics in the literature, with a few exceptions [14-18] but no explicit respiratory ethics framework that this author can find other than a brief outline given by a doctor in 1918 that we will examine shortly. More recently, Margaret Battin and colleagues have described a conspicuous absence of ethical frameworks for infectious diseases.

[D]uring the formative period of bioethics, infectious disease played virtually no role. As concern with infectious disease seemed to be waning, interest in bioethics was growing apace; the two never really met, to the disadvantage of bioethics. [19]

Battin and colleagues published a bioethics framework for infectious disease that centers on understanding that infectious disease patients are both victims and potential vectors. [20] While their framework takes the standpoint of medical professionals treating patients, the personal ethics framework presented herein takes the standpoint of the common person and their ethical obligations to their fellows. The framework herein also centers *airborne* infectious diseases due to unique ethical issues arising from their mitigation. But let us first examine ethical arguments for respiratory hygiene over time to look for signs of a common ethical framework.

Historical Background

Discovery of the microbial causes of infectious diseases in the late 1800s is among the important achievements in human history because it allowed for the effective mitigation of diseases that had plagued humanity since the dawn of time. Knowing that infectious diseases are caused by microscopic germs carried by water, air and food informed the First Public Health Revolution (1880-1920), which improved human health and lifespan through public sanitation measures such as water treatment, refuse management, food inspection, ventilation standards and the promotion of personal hygiene practices. [21,22]

Informed by germ theory, early advocates of public health made ethical appeals that revealed moral foundations for infectious disease mitigation. For example, in the 1890s, physician George Vivian Poore advocated for public sanitation and other measures to control the spread of germs and in so doing appealed to a moral obligation to not endanger the health of others.

It is the duty of each of us to take care that we do not, by apathetic carelessness or culpable ignorance, endanger the health of others, and we must remember that it is no excuse for the adoption of bad and dangerous methods of sanitation to urge that they are 'convenient.' [...] We are individually under a moral obligation to see the refuse of our dwellings safely bestowed, so as not to endanger the health of others. [...] by merely 'passing on' our refuse to be a nuisance elsewhere than on our own premises, we show a forgetfulness of our duty towards our neighbour and we do unto others that which we are unwilling that others should do unto us. [23]

Poore appealed to preventing harm to others and to the timeless Golden Rule, do unto others as you would have them do unto you. Poore also advocated for sanitation of the air stating: “our moral responsibilities with regard to the air we breathe are very great. Our first duty is not to foul the air more than we can help, to keep all about us clean and pure.” He therefore advocated for indoor ventilation to reduce concentrations of infectious airborne germs. [24]

Over the next decade, Poore’s moral duty to keep the air around oneself clean evolved into specific personal methods of *respiratory hygiene*. During the 1918 influenza pandemic, community use of face masks arose and was even mandated in some U.S. cities to mitigate the airborne transmission of influenza. [25] During that pandemic an framework for respiratory hygiene ethics was outlined by physician Donald Armstrong in the following passage.

It was Professor Sedgwick who reduced prevention of typhoid to its simplest expression by saying, that it is merely necessary “to keep the bowel discharges of A out of the mouth of B.” In influenza it is likewise true that prevention will find a most substantial foundation if the oral discharges of A can be kept out of the throat of B. If this is to be done at all, it must be largely through the care taken by the individual in what is termed, “respiratory hygiene.” The responsibility lies with the individual. It is his duty towards his neighbor, on the part of the infected man, to prevent the scattering of his germs among his fellow men; it is his duty to himself on the part of everybody, to guard the portals of entry of his body against the microbes of others. [26]

In this passage Armstrong outlines a framework for respiratory ethics centered on individual responsibility and an obligation to prevent infecting others with one’s own germs. He articulates two goals of respiratory hygiene, (1) do not become infected and (2) do not infect others. He seems to be saying both goals aim to protect others. The infectious disease ethics of both Poore and Armstrong appeal to the individual and our personal duty to take action so as to prevent becoming vectors of physical harm to others around us.

After the 1918 pandemic, respiratory hygiene became a part of daily life. Public health slogans such as “coughs and sneezes spread diseases” encouraged the use of handkerchiefs. [27] Handkerchiefs are face coverings used to cover coughs and sneezes so as to capture outbursts of respiratory effluent and any germs therein before they reach others. Their use to mitigate infectious diseases like the common cold was taught in schools for decades after the pandemic. This vignette of school life in 1935 reveals that the use of handkerchiefs was encouraged by appealing to an ethical duty to avoid harming the health of others.

In a class of girls, one came to school with a very bad cold. Soon the girls near her caught the cold, and as a result a discussion of cold prevention came up in the roll-room meeting. It was found that the first girl had been careless in the use of her handkerchief to cover sneezes and coughs. The roll-room president appointed a committee to see that each girl had a clean handkerchief daily. The discussion also brought out the fact that girls who spread colds when they can prevent doing so are thoughtless and selfish. [28]

The admonishment of students who fail to practice respiratory hygiene as thoughtless and selfish invoked an ethical duty to not endanger the health of others and to thus take action to utilize available means to prevent infecting them with your germs, even mere common-cold germs.

These examples make clear that since the dawn of germ theory respiratory hygiene has been grounded in an ethical obligation to take actions to prevent oneself from harming others with one's own germs. The examples also demonstrate that respiratory hygiene is not obligatory due to legal mandate — in fact, no laws require that we cover coughs and sneezes — and respiratory hygiene is not obligatory simply because it became common etiquette. Respiratory hygiene is obligatory because it is unethical to endanger others with the physical harms that infectious respiratory effluent can cause. Independent of decree or custom, this ethics of non-harm resides in the primacy of human intuition and the timeless Golden Rule, perhaps the oldest ethical principle, which obligates that if you do not want others to cause physical harm to you, you should not cause physical harm to them.

Following the wisdom of our elders, a framework for respiratory ethics should be centered on the ethical principles of *nonmaleficence* and the *beneficence* of taking actions for the benefit of others, specifically by practicing respiratory hygiene to prevent oneself from wittingly or unwittingly becoming a vector of physically harmful infections to others.

The Ethical Context of Respiratory Hygiene

While most ethics pertain to interactions between at least two people, respiratory hygiene exists within the context of at least three de facto actors, (1) an infector, (2) an infectee, and (3) an infectious pathogen that infected the infector causing them to act as a vector by way of which the pathogen then additionally infected the infectee. This third-actor factor and the third actor's victimization of the infector absolves unwitting infectors of moral culpability even when people die as a result of pathogens they unwittingly spread. However, the degree of an infector's unwittingness is an important variable in the assessment of their moral culpability. Those who know they are infectious, take no precautions and thereby infect others are morally culpable.

Given the presumed moral innocence of an unwitting infector, the spread of infectious disease is often seen as an *act of nature* rather than an act of humans. However, the 'acts of germs' are inseparable from human actions because germs require our activity to spread, activities we are free to choose to modify so as to prevent spreading them. Therefore, spreading germs lies at the intersection of acts of nature and acts of humans as illustrated in Figure 1a.

The ethics of respiratory hygiene arises in the intersection of acts of nature, acts of humans and scientific knowledge about how germs spread disease, as depicted in Figure 1b. When we discover something that harms people and discover actions we can take to mitigate that harm, we also discover new ethical obligations to take those mitigative actions. So when we discovered

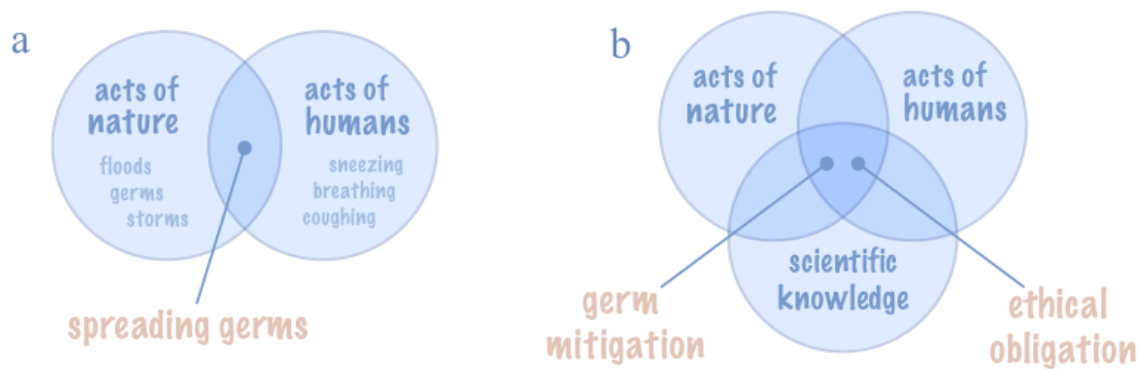


Figure 1: (a) Spreading germs exists in the intersection of nature's and our actions, nature does not act alone to spread germs. (b) Scientific knowledge revealing how our actions spread harmful germs to others brings about an ethical obligation to modify our actions to avoid spreading harmful germs to others.

that respiratory effluent can harm people and that respiratory hygiene can mitigate that harm, we discovered an ethical duty to practice respiratory hygiene.

Knowledge is morally transformative not only in the broader context of the discovery of germs but also in the narrow context of individuals being personally aware that they might be vectors of harmful germs. The moral innocence of someone who is a vector is contingent on the degree of their unwittingness about being a vector. Anyone who knows they can be asymptomatic and also a vector of infectious disease can hardly claim perfect unwittingness even if they feel fine, for they *know* they could nevertheless be a vector of harm to others. Therefore, respiratory hygiene is always obligatory at least in so far as you should adhere to its basics such as covering coughs and sneezes, not spitting in public and wearing a mask during a pandemic.

A Respiratory Ethics Framework



Figure 2: The four columns of this Respiratory Ethics Framework: *what*, *how*, *why* and *when*.

This Respiratory Ethics Framework (REF) can be mnemonically envisioned as an edifice buttressed by four pillars that inform us *what* respiratory hygiene is and *how*, *why* and *when* we should practice it, as depicted in Figure 2.

What is Respiratory Hygiene?

Respiratory hygiene prescribes a set of personally initiated practices intended to reduce the likelihood of transmitting a contagious respiratory infection to others by way of respiratory effluent. Respiratory effluent is composed of droplets of saliva and other secretions and is emitted from the mouth and nose into the air while coughing, sneezing, spitting, vocalizing or breathing. Larger droplets of effluent fall onto surfaces within a few feet while smaller droplets float in the air as aerosols that remain airborne for longer periods of time during which they can travel further distances. Respiratory droplets can spread pathogens enclosed within them when they are inhaled by others or when others touch surfaces upon which they fell. Respiratory hygiene is an effort by individuals to prevent their respiratory effluent from entering the bodies of other people so as to reduce the spread of infectious pathogens between people.

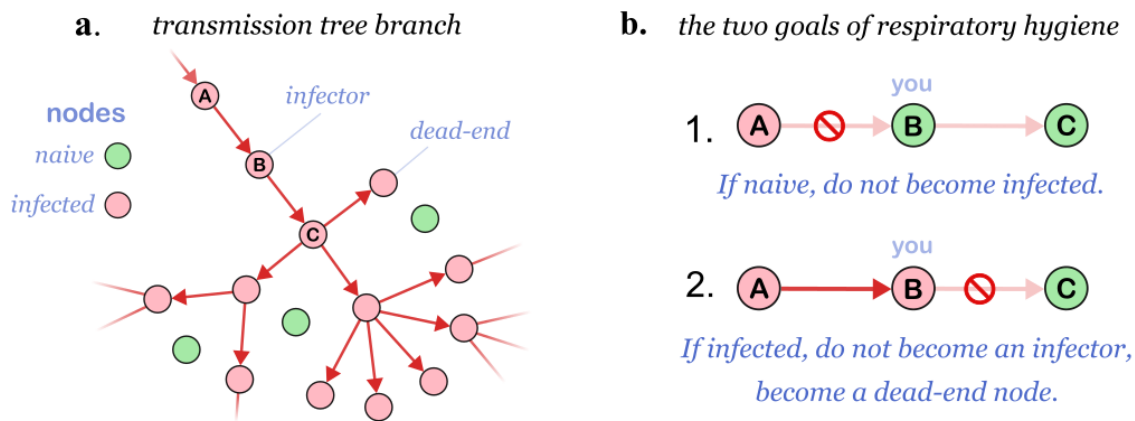


Figure 3: (a) This phylogenetic tree branch depicts the transmission paths of an infectious airborne pathogen with red arrows starting from person A and spreading to person C and others depicted as red dots, or nodes. Green dots are people who were not infected. (b) Here are the two goals of respiratory hygiene per person, first, do not become infected, and second, do not infect others if you are infected.

The spread of contagious respiratory pathogens can be visualized as a phylogenetic transmission tree, as seen in Figure 3a wherein each infected person is a red dot, or node, on a branch of the tree and green dots are people outside the tree who were not infected. Figure 3b illustrates the two goals of respiratory hygiene per person, which is to prevent becoming (1) an *infected node* and/or (2) an *infector node*. Given you could be infected with a respiratory pathogen and not know it, both goals are simultaneously aimed for. For example, even as you avoid close contact with someone who is infected (goal one) at the same time you cover your coughs to protect others from an infection you might unwittingly have (goal two). And even if you are infected

with one pathogen (the antecedent condition of goal two), you would simultaneously avoid someone infected with another pathogen (goal one). So both goals can be in play at once.

How is Respiratory Hygiene Implemented?

It is one thing to have the goal of preventing the spread of airborne respiratory pathogens and another to know *how* to achieve that goal. Aside from quarantine, ventilation and vaccination the most effective method of respiratory hygiene is coverings your respiratory outlets, mouth and nose, in order to capture and thereby reduce the volume of respiratory effluent you emitted into your external environment. As depicted in Figure 4, there is a spectrum of such face coverings from the least effective on the left to progressively more effective coverings to the right.

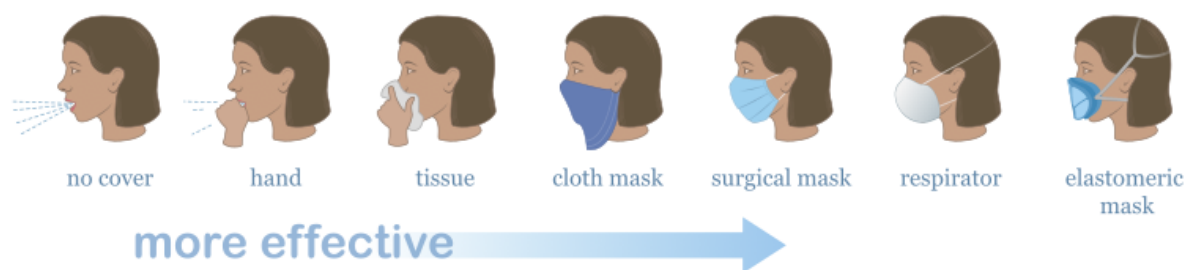


Figure 4: spectrum of respiratory covering from less (on left) to more effective (on right).

There are two modes of face-covering efficacy, *self-protection* and *source control*, which correspond respectively to the first and second goals of respiratory hygiene (see Fig. 3). Self-protection is achieved by filtration of inhaled air with a mask to block airborne respiratory effluent from others before it is inhaled by the wearer, thereby protecting the wearer. Source control is the capture of infectious respiratory effluent at the source — mouth or nose — before it spreads to others. While covering coughs and sneezes with a hand, elbow or tissue can implement source control, only masking can implement both goals of respiratory hygiene.

Masks primarily capture pathogens by capturing respiratory droplets containing them. Masks can also capture free-floating germs smaller than gaps between mask fibers by direct interception, Brownian-motion diffusion and electrostatic attraction. [29] For over a hundred years masks have been shown in laboratories to filter germs, [30, 31] and more recently have been shown to filter SARS-2 virions. [32, 33] While the filtration efficacy of masks is typically imperfect, meta-analyses of studies of mask use in real-world settings favor the likelihood that they reduce the spread of airborne germs, [34-36] including the beta-coronaviruses. [8] Null results for some mask studies routinely cited by mask critics have been shown to be attributable to being statistically underpowered and thus lacking the means to detect even a strong effect. [37]

By reducing the volume of virus shed by infectors and inhaled by others, masks may reduce both the number of infections and the severity of the infections they fail to prevent. [38] Not all exposures to a pathogen produce an infection. The *infective dose* of a virus is the estimated

number of virions needed to infect 50% of susceptible individuals. So being exposed to low doses of germs may not lead to an infection. Furthermore, being exposed to larger doses of germs may lead to more severe disease. A dose-response relation between higher exposure doses and more severe illness has been reported for many infectious diseases including influenza, measles, tuberculosis, streptococcus, HIV, human coronavirus, SARS-1 [39] and SARS-2. [40-42] It has also been reported that filtration of SARS-2 virions with masks reduced both the number and severity of airborne-spread infections in an animal model. [43]

While face covering is the most direct method of reducing emission and inhalation of respiratory effluent, respiratory hygiene includes indirect measures such as hand washing, cleaning common surfaces, staying home when sick, opening windows for ventilation, vaccination, etc. A measure of respiratory hygiene is any measure intended and able to reduce interpersonal exposures to respiratory effluent. Given that you could be asymptomatic and infectious, under our normative ethos everyone is always obligated to practice at least minimal respiratory hygiene measures such as covering coughs and sneezes just in case you happen to be infectious.

Why Should Respiratory Hygiene be Practiced?

The ethical core of REF resides here in its *why* column. This core is an axiomatic model resting upon the harm principle, also known as the *principle of nonmaleficence*. Causing harm to others is not always unethical. For example, causing financial harm to a business by posting truthful negative reviews is not unethical. The primary type of harm respiratory hygiene seeks to mitigate is *bodily physical harm* ranging from mild to catastrophic caused by germs carried in respiratory effluent. Whether by intent or accident, causing bodily physical harm to others is one of the least ethically ambiguous types of harm. It is only permissible in a few circumstances like self-defense and least-harm tradeoffs such as amputating your leg to save your life.

The axiomatic model forming the ethical core of REF is composed of the following two informal stepwise annotated arguments built from an axiom that captures the ethical duty resident in the classical harm principle. Warrant for each step is annotated to its right.

Argument 1 does the work of deriving from the negative harm principle its implicit positive duty to initiate precautionary actions required to *prevent* causing harm to others in the future.

- | | | |
|--|--|-------|
| 1. Do not cause harm to others without justifiable reason. | | axiom |
| 2. Therefore, take precautions to prevent yourself from causing harm to others without justifiable reason. | | by 1 |

The negative duty to not cause harm to others requires that you take *positive* actions to prevent *your* actions from possibly causing harm to others. For example, if you should not harm others, then you should carefully secure a heavy load strapped atop your vehicle to prevent it from tumbling off into traffic and thereby harming others. While often seen as a negative duty, the

harm principle is a positive duty insofar as it requires that you take actions for the benefit of others, specifically actions to prevent yourself from causing harm to them.

Argument 2 implements the duty to prevent harm to others derived from Argument 1 within a factual context that is relevant to the goals of respiratory hygiene.

1. Take precautions to prevent yourself from causing harm to others without justifiable reason.	by Argument 1
2. Being a vector of an infectious disease can cause mild to catastrophic bodily physical harm to others.	fact
3. Take precautions to prevent yourself from becoming a vector of infectious disease without justifiable reason.	by 1, 2

Probably most people agree with this conclusion because it already resides in consensus ethics. Everyone knows you should try to avoid infecting others, even with the common cold. Anyone who knowingly infects others without warning them is normally seen as morally reprobate. However, where people disagree is over *the lengths* we should go to avoid being a vector. If those lengths are too far, we effectively activate the ‘justifiable reason’ clause, or the *just-cause clause*, which resides in the harm principle. So then what is a justifiable reason?

People differ over what constitutes ‘just cause’ to forego respiratory hygiene measures. Some will say a just cause for going to work while sick is being able to pay the rent. Others will say a just cause for not wearing a mask during a pandemic is simply not wanting to. Yet these examples of just cause do not hold for other ways of causing physical harm to others. You cannot justify allowing your actions to cause bodily physical harm to others on the basis that it pays the bills or because you simply do not care. Members of an ethical community are not at liberty to inflict bodily physical harm upon other members for money or convenience.

Nevertheless, we have all used the just-cause clause. For example, should we have worn hazmat suits during the Covid-19 pandemic if doing so would reduce harmful transmissions? Everyone agrees the answer is *no*. Why? Because living in hazmat suits would impose an extreme reduction in the quality of life for everyone, and that is also a type of harm. But suppose a new lethal virus emerges tomorrow and only two people have it. In that context, isolating them and having only the few people in close proximity to them wearing hazmat suits could save millions of lives. So there are thresholds for *when* to activate various measures in the respiratory hygiene toolkit, and the just-cause clause is a dial with which we can scale up and down the range of those tools, fine-tuning our mitigation measures to match various contexts. We shall further refine the context-dependent nature of respiratory ethics in REF’s *when* column.

When Should Respiratory Hygiene be Implemented?

Under contemporary western ethos, basic measures of respiratory hygiene are *always* obligatory as means to prevent the spread of germs. Covering coughs and sneezes is always at least weakly obligatory. Even if you do not believe you are infectious you should, by common ethos, cover respiratory events just in case you are. Staying home when you have a respiratory infection is also at least weakly obligatory. Since the Covid-19 pandemic the ethos in some eastern countries like Japan has expanded to include wearing a face mask as always at least weakly obligatory even in the absence of mandates. [44] In the west, however, masking is almost always not obligatory and the perception of it ever being obligatory is associated with it being obligated by legal mandate rather than by pre-legal natural ethics.

But why should we scale up respiratory covering with hands, elbows or tissues to wearing a face mask? By the harm principle, we should improve the efficacy of our respiratory covering when the likelihood that our respiratory effluent could harm others increases. That likelihood increases dramatically when we are actively infectious with an airborne pathogen. Face masks not only capture more respiratory effluent than a hand or elbow, [45] unlike a tissue they provide continuous covering so that infectious respiratory effluent emitted while breathing and vocalizing is also captured. [46] Therefore, if you believe you are probably infectious, you should scale up your respiratory covering by wearing a mask. This reasoning is organized in Argument 3.

Argument 3 is a stepwise informal argument that derives from the ethical norm of covering coughs and sneezes an obligation to wear a mask when you are infectious. Herein, ‘you’ refers to anyone, ‘infectious’ regards airborne pathogens and obligations apply to settings where germ transmissions could occur, especially indoor congregate settings.

1. To stop germs, cover coughs and sneezes even if you are probably not infectious just in case you are.	ethical norm
2. If you are probably infectious, you are probably shedding germs with every breath or vocalization.	fact
3. If you are continuously shedding infectious germs, you should exercise continuous respiratory covering.	scaling 1 to context
4. Face masks provide continuous respiratory covering.	fact
5. If you are probably infectious, you should wear a mask.	by 2, 3 and 4

The work done here occurs in step 3 wherein the ethical norm in step 1 is scaled up to match a circumstance wherein you are probably spewing harmful germs into other people. Your ethical obligation to mask is a function of your likelihood of being a vector of harm to others. This up-scaling is recognized across risk domains. For example, to carry a small load on a truck lower gauge straps may be sufficient but a large load may require a higher gauge to prevent the cargo

from tumbling off into traffic and harming others. When your risk of causing harm to others increases, your mitigative actions should scale up as required to counter than increase.

So, the question of when are you ethically obligated to mask can be answered computationally with a one-dimensional model REF_M^1 that has a function ‘Infectious()’ that maps the set of your possible beliefs about the probability that you are infectious {*unlikely, possibly, probably*} into the set of degrees of obligation {*zero, weak, strong*}, such that,

Infectious(*unlikely*) = *zero*

Infectious(*possibly*) = *weak*

Infectious(*probably*) = *strong*

In other words, if you believe you are probably infectious, you are strongly obligated to mask; if you believe you are possibly infectious, you are weakly obligated to mask; and if you believe it is unlikely that you are infectious, you have no obligation to mask. Such progressive degrees of obligation used in deontic logic and medical ethics [12,47] accurately reflect ethical obligation as it exists in real life and language which is replete with terms denoting degrees of obligation such as *may, should, ought* and *must*. REF_M^1 provides a basic and simple decision-making framework for general purpose use. There is, however, another variable worthy of consideration.

A second ethical variable, *vulnerability*

While probability of infectiousness is an important ethical variable, another is the *vulnerability* of others to harm from infection. Suppose you believed it is unlikely you are infectious and you are planning to visit a nursing home whose residents have high risk of harm from infections. In that case you may decide that you should wear a mask to protect them from physical harm even though by REF_M^1 you are not so obliged. You may reason that the increased vulnerability of the residents increases the likelihood that you could cause harm if you actually *are* infectious despite your belief otherwise. That increased risk calls for increased vigilance to prevent causing that harm. So the two variables, infectiousness and vulnerability, are calculated in the matrix illustrated in Figure 5 which forms the two-dimensional model REF_M^2 that has a three-valued scale of obligation where 0 refers to what you *may* do, or no obligation, 1 refers to what you *should* do, or weak obligation, and 2 refers to what you *must* do, or strong obligation.

The matrix in Figure 5 is read in two ways corresponding respectively to the first and second goals of respiratory hygiene shown in Figure 3b: (1) The ‘infectious?’ axis is your estimation of the likelihood that you will come in close proximity to an infectious person and the ‘vulnerability’ axis is your estimation of your vulnerability to becoming infected. (2) By the second reading the ‘infectious?’ axis is your estimation of the probability that *you* are infectious (same as the reading of REF_M^1) and the ‘vulnerability’ axis is your estimation of the vulnerability of others near you to adverse outcomes of infection. Just as both goals of respiratory hygiene can be in play at once, these two readings of this matrix can as well.

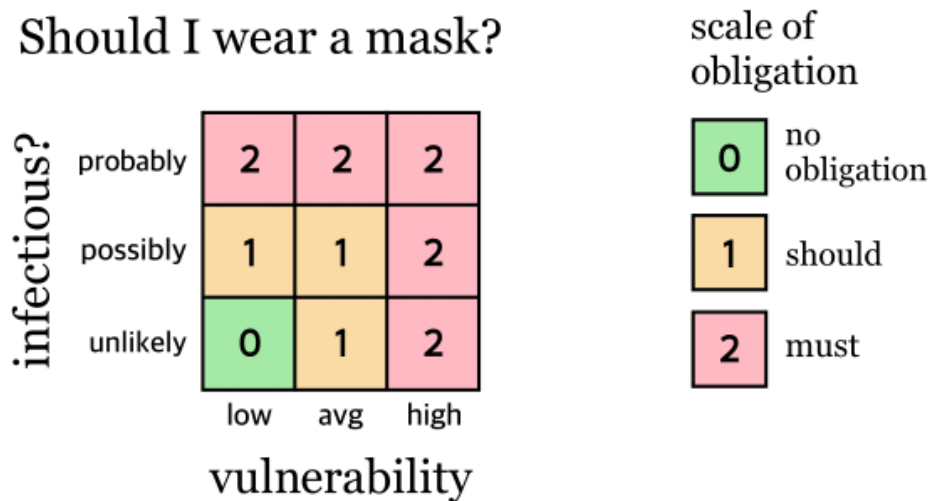


Figure 5: This ethical decision matrix coordinates two variables regarding your beliefs about your risk of spreading harmful infection to others. If your beliefs intersect at 0, you have *no* obligation to mask. If your beliefs intersect at 1, you are *weakly* obliged to mask. If your beliefs intersect at 2, you are *strongly* obligated to mask.

The vulnerability variable has two different interpretations. In the first reading the vulnerability axis refers to your vulnerability to becoming infectious whereas in the second reading it refers to the vulnerability of others to adverse outcomes from infection. These two interpretations of ‘vulnerability’ reflect the underlying ethics. From the ethical perspective, the purpose of avoiding infection is preventing oneself from becoming a vector of harm to others and the purpose of not infecting others is preventing physical harm to them. Preventing harm to oneself is a matter of ethics only insofar as such harm may in turn cause harm to others. For example, a parent of a young child has an ethical duty to protect themselves from harm so as to prevent their child from losing a parent who they need in order to maximize their chance of optimal flourishing.

Let us consider a few scenarios where the matrix is applied. Under the first reading, an example of believing that your vulnerability to infection by an airborne pathogen is low is if you believe you have recently acquired immunity to that pathogen. On the other hand, if you believe you do not have immunity to a pathogen, you would probably believe your vulnerability to it is high. We previously considered an example of the second reading of ‘vulnerability’, believing nursing home residents are highly vulnerable to adverse outcomes of infection. In another scenario, if those around you are healthy young adults, you may believe their vulnerability to adverse outcomes is low. However, any group may have members with such high vulnerability or know others with such vulnerability to whom they could become infective vectors.

An REF decision that you must mask when infections does not mean going to work with a mask is preferable to staying home. Staying home when sick is preferable to going to work with a mask. However, these two decisions are not mutually exclusive. Many workers who believe they are probably infectious live with roommates or family members, so even at home they must wear

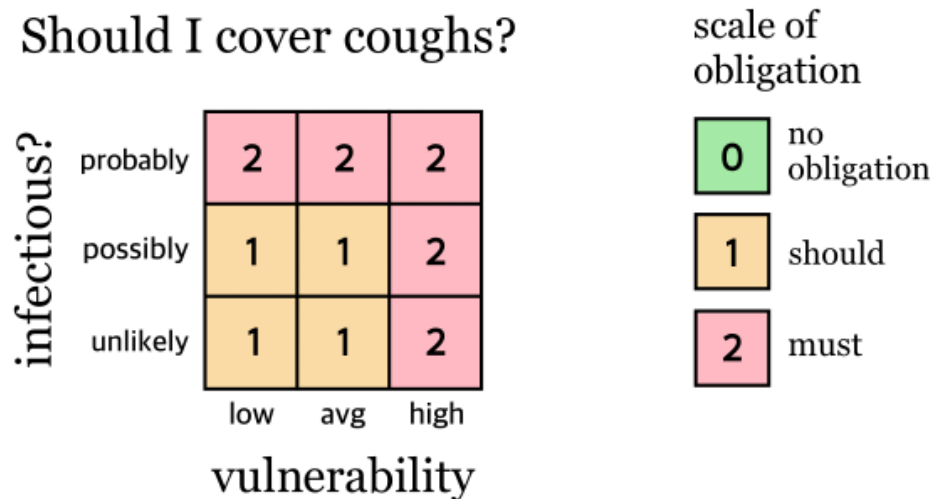


Figure 6: this instantiation of the matrix approximates the consensus respiratory ethics under which it is *always* obligatory to cover coughs and sneezes.

a mask to protect others around them from their infectious respiratory effluent that can pose a viable risk of infection for many hours after being shed. So, by REF, the worker dutifully staying home when sick must wear a mask in their private residence anywhere others may be during the day, unless those others consent to the risks of their going maskless. But even if an infectious person's family members do so consent, the ethical decision remains to mask nevertheless. The infectious person must wait for their infection to clear to unmask.

REF_M² can be repurposed to model decisions about other measures of respiratory hygiene such as covering coughs in model REF_M^{2,1} in Figure 6 where the question applies equally to covering sneezes. However, in this case, rather than informing decisions the Figure 6 matrix describes consensus ethical decision making. There is no circumstance where its is permissible to cough or sneeze near others without covering at least with your hand. How strong that obligation is in these contexts may be debatable, but that obligation to cover coughs and sneezes exists in all the contexts in the matrix is descriptive of the contemporary ethical consensus.

Figure 7 opens up a fuzzy continuum of ethical obligation wherein the ethical category of *should* is transformed from Figure 5 into variable degrees of should between no and strong obligation. This model is REF_M^{2f}, meaning a fuzzy two-dimensional model for REF. It is to be understood that in this model the obligation value 1 ranges over rational numbers between 0 and 1 such that this scale of obligation runs: 0, 0.1, 0.2, ..., 0.9, 1, 2. Examples of fuzzy degrees of *shouldness* in English are: 'maybe you should', 'probably you should' and 'definitely you should'. In this matrix the y-axis range of values for *possibly* spans a continuum from being less to more possibly infectious and the x-axis range for *average* spans a continuum from having below to above average vulnerability. REF_M^{2f} models how obligation exists in real life ethical decision making more accurately than the low-resolution model REF_M² in Figure 5.

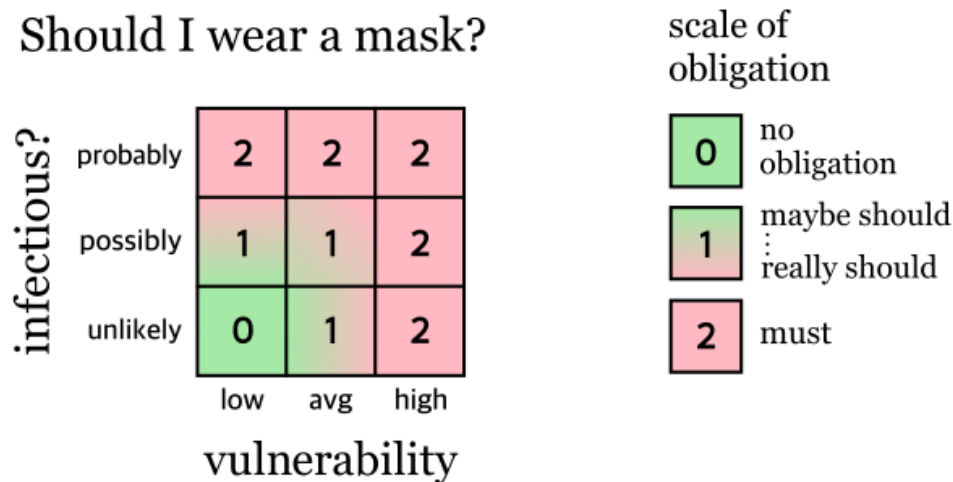


Figure 7: This model transforms ‘should’ in Figure 5 into degrees of *shouldness*. Number 1 above ranges over: 0.1, 0.2, ..., 0.9, 1. This fuzzy scale reflects how obligation actually exists under ethical decision making in real everyday life.

One might object that because the matrices rely on wide variations in personal determinations they are too imprecise such that almost any decision can be reached. After all, its terms such as ‘unlikely’ and ‘average’ are defined by the whims of individuals. However, this flexibility is a feature, not a bug, of common parameters. If everyone shares the common parameter that only self-defense justifies homicide, while some may quibble over what constitutes ‘self-defense’ just as they may quibble over what constitutes ‘unlikely’, that is nevertheless preferable to a world with no common parameters. REF is a personal ethics framework and that aims to model the reasoning available to anyone acting in realtime with imperfect knowledge. Most circumstances may be defined by some as falling within the no obligation square while by others as falling outside it. However, they should all agree that an infectious person must wear a face mask when in proximity to others. Insofar as the matrix has common parameters, it provides a common meta-ethical framework available to everyone.

Summary & Discussion

Motivated by ethical questions arising from the Covid-19 pandemic, the Respiratory Ethics Framework (REF) presented above addresses the questions of why and when we should wear a face mask for respiratory hygiene. REF builds answers for those questions from assuming the classic harm principle as an ethical axiom, which reflects consensus ethics, and deriving therefrom an ethical obligation to practice respiratory hygiene. Then in Argument 3, based on the ethical norm of covering coughs and sneezes, REF establishes an ethical obligation for anyone to wear a face mask when they believe they are probably infectious. That pivotal argument actually clears a low bar because it is obvious that if you are spewing harmful airborne germs into the lungs of others with any breath or vocalization, the only plausible ethical decision is to take actions required to *stop* exposing others. The best way to stop is self-quarantine, which is to say

staying home. Where quarantine is imperfect or impossible, masking is the second best method to stop spewing germs into the bodies others. Then, with simple computational models, REF provides context-mapped visualized tools for ethical decision making. REF_M^1 is a one-dimensional model for REF based on your belief about the probability that you are infectious. REF_M^2 is a two-dimensional model for REF based your beliefs about infectiousness and vulnerability. The fuzzy model REF_M^{2f} then adds high-resolution modeling of ethical decision making under a wide spectrum of circumstances. Fuzziness may also be added to REF_M^1 .

Contentious disputes over face masks that arose during the Covid-19 pandemic, as well as during the 1918 influenza pandemic, [48] were motivated by opposition to masks being *legally* obligated. Lost in the heat and noise of that battle are more subtle questions about to what extent masks might be *ethically* obligated. Ethical obligation and legal obligation are two different things that can be decoupled. For example, we are ethically but not legally obliged to cover coughs and sneezes. But spitting in public became illegal in many jurisdictions after its propensity to spread germs was discovered. [49] So not spitting in public is a measure of respiratory hygiene [50] that is both ethically and legally obligatory. Therefore, measures of respiratory hygiene can be ethically obligatory whether or not they are legally obligatory. REF stands outside the legal debate because it is a personal ethics about your obligations to others under the harm principle and Golden Rule irrespective of any legal mandates that may or may not be in place. That said, if there is a mask mandate in place yet REF guides you to not mask, it is reasonable to err on the side of not being a vector of harm and abide by the mandate.

The thoughtful reader has probably noticed in REF's *when* column gives no explicit guidance on decision making during a pandemic. REF is intended to be applicable at any time irrespective of pandemics. During a pandemic the honest person increases their values for infectiousness and vulnerability. The risk of harm to others due to being wrong about believing you are not infectious increases during a pandemic. The risk of being infected also increases. These increased risks entail an ethical obligation to increase the efficacy of respiratory-hygiene measures as required to counter that increase, and masking is about the only next-level up from using hands, elbows or tissue papers for respiratory covering. So REF does implicitly provide guidance for decisions under pandemic conditions. REF's decision matrices, especially REF_M^{2f} , provide guidance under a wide range of circumstances in part due to the flexibility of their user-defined values such as 'unlikely', 'low', 'possibly' and 'average'.

REF is based on honestly held beliefs that may be concealed. Someone who actually believes they are probably infectious but outwardly denies it to justify taking no mitigative actions around others is behaving unethically despite their professed belief. If their concealment should be uncovered, they are due moral censure. But if they do successfully conceal their true beliefs, they may get away with wrongfully infecting others. Similarly, if someone successfully conceals their connection to a murder they committed, they will get away with that. And someone who believes they are infectious and then infects another who thereby dies could be subject to legal consequences in some jurisdictions, [51] with a pivotal factor being whether or not they believed they were infectious. Believing that you were engaged in actions with a high risk of injury to

others is sufficient to transform civil negligence into criminal negligence. [52,53] So, while it might seem that an ethics based on one's beliefs is too subjective, ethics and law are very much grounded in what a person believes. Belief and knowledge are morally transformative.

Some may object that REF is too permissive against asymptomatic spread. Deciding to not mask based on the belief that one is unlikely to be infectious is a recipe for failing to prevent asymptomatic spread. While those with asymptomatic SARS-2 infections are probably less infectious, [54] asymptomatic spread is believed to have been an important driver of the Covid-19 pandemic. [55] These facts give reason for you to believe you are 'possibly' rather than 'unlikely' infectious and thereby be obliged to mask. REF's models could guide you to decide to always mask around others if you believe it is always possible that you are infectious with some airborne pathogen even if you feel fine. So REF does in fact accommodate these considerations regarding asymptomatic spread. However, REF leaves it to individuals to assess what values they will ascribe to the infectiousness and vulnerability variables. Leaving the decision to individuals is the default in the absence of mask mandates. What REF offers at least is a greater likelihood that more people will decide to mask when they are symptomatic. If all who are symptomatically infectious chose to mask, as would be the case if REF's masking ethics became the norm, there is little reason to doubt that we would observe a substantial reduction of the morbidity and mortality inflicted on humanity by airborne infectious diseases.

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