



Best practices to prevent airborne diseases

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Abstract

Airborne diseases has always been a big public health challenge like demonstrated in the recent pandemic of COVID 19 and ongoing threats from respiratory viruses like influenza, RSV etc. This paper discusses the best practices to prevent the spread of airborne disease through a comprehensive strategy. I will be drawing evidence from recently published research, public health agencies, and announcements of updated clinical guidelines. The research paper will be identifying the four main pillars for disease prevention which are: vaccination and personal hygiene, organizational preparedness, ventilation and air quality improvements along with respiratory protection and source control. This research's conclusion is that no single safety measure is sufficient and the public must use all the safety measures and strategies to offer the most protection against airborne disease transmission in many places, like hospitals, community settings and workplaces. The findings have many implications for individual behavior change and public health policy.

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I. Introduction

Respiratory viruses cause millions of illnesses and thousands of hospitalizations and deaths every year. The COVID 19 pandemic had fundamentally changed how scientists and people working in public health viewed and understood the transmission of respiratory pathogens. One big finding was the importance of airborne mode in disease transmission and how the inhalation of the virus through airborne transmission has been dominating the infection chains and fuels pandemics like the COVID 19 pandemic (2). The World Health Organization also known as WHO has since updated its terminology about airborne transmission, defining airborne transmission as occurring when infectious particles respiratory enter the respiratory tract through inhalation at either short or long distances. (10)

Unlike diseases that spread through direct contact or large droplets that fall to the ground quickly, airborne viruses are different as they can remain up in the air for extended periods of time, especially in indoor areas with poor ventilation.(3) There is more of a chance of inhaling the virus indoors than outdoors as the concentration of the particles is often more indoors. This means that for effective prevention people will need to do more than just hand washing and surface cleaning and address the problem in the air itself

This paper examines what the best practices are for the prevention of airborne diseases in different settings like a school, office, hospitals etc. The research paper argues that for effective disease prevention, a multi part strategy will be needed combining multiple aspects like vaccination, respiratory protection and organizational preparedness. This paper is divided into 4 sections, which are: prevention strategies for individuals, respiratory protection and source control, ventilation and air quality and organizational and policy approaches. The conclusion combines these aspects into recommendations to follow for disease prevention.

Prevention strategies for individuals

Immunizations

Immunization is the process of protecting a person from an infectious disease by introducing a substance into the body (11) typically through vaccination. Staying up to date with the recommended immunizations is one of the best ways to prevent airborne transmitted diseases. (4) Vaccines that are there for COVID 19, influenza and RSV have been shown to reduce the chance of severe illnesses, hospitalizations and even death. Public health officials recommend that individuals should consult with healthcare providers to discuss which vaccines are best to take for the individual and their family (4). Vaccines are especially important for people with high risk factors

that increase their chances of getting very sick. The timing of the vaccines is also very important as vaccines usually take time to work so it is best to get the vaccine before the virus begins to spread. (4)

Personal Hygiene

Personal hygiene is another factor that is essential for prevention. This factor includes washing hands regularly with soap and water, using hand sanitizer when handwash not available, and cleaning surfaces that are commonly touched to avoid transmission. (4) Following these practices can help reduce indirect transmission, but they are less related to airborne transmission than other measures. But personal hygiene is still an essential part of preventing disease.

Staying Home When Sick

Staying home when sick can be an important but a very overlooked factor in preventing transmission of airborne disease, staying home and staying away from others when sick with a respiratory illness. (4) This is a form of source control as the individual prevents the infected person from spreading respiratory illness to others. People with risk factors for severe illness should seek healthcare promptly as it can lower their risk for complications (4). This strategy is important in places like schools and workplaces where transmission can occur quickly.

What Are the Key Times for Prevention

The strategies listed above are especially important during times when respiratory viruses are starting to cause significant illness in the community, when individuals and people around them have gotten sick recently and are still recovering or when individuals or people around them have risk factors for severe illness. (4)

Respiratory Protection and Source Control

Understanding how airborne transmission works

WHO has updated its terminology which distinguishes the difference between both the components of airborne transmission (10):

There is long range airborne transmission where individuals inhale infected particles when they are suspended in the air of the room they are in

There is short range airborne transmission where individuals inhale the particles directly transported from the exhaled breath of the infected person while in a close proximity

These two components are important to differentiate because by knowing this, they can affect what methods of prevention are most effective. Short range exposure had 10 times the viral dose than long range dose in some settings like patient wards. (2) This information highlights that PPE is very important, especially in health care.

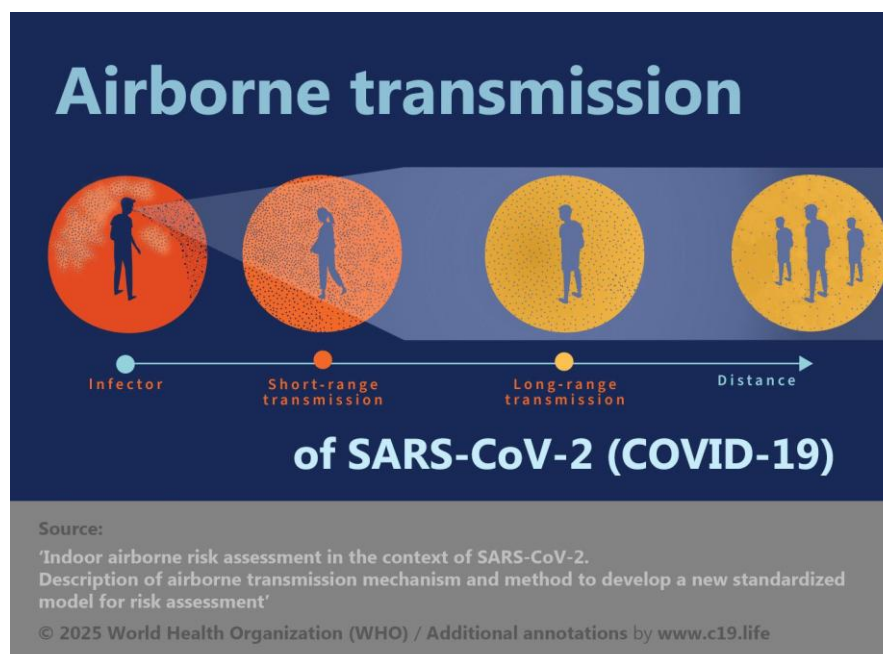


Fig 1: The change in the concentration of infected particles through the distance from the infected person (13)

Respirators and Masks In Prevention

Research shows that respirators like FFP2 and N95 can reduce the viral dose of airborne illnesses very effectively. One study found that by wearing a FFP2 respirator resulted in a 13 fold decrease in the viral dose(2) and a 2024 study also found that N95 respirators reduce the exhaled viral load by 98 percent which significantly better than surgical masks. These respirators are a lot more effective than surgical masks, which are designed to protect the other patients from the droplets produced from the wearer, not the wearer from airborne pathogens (10).

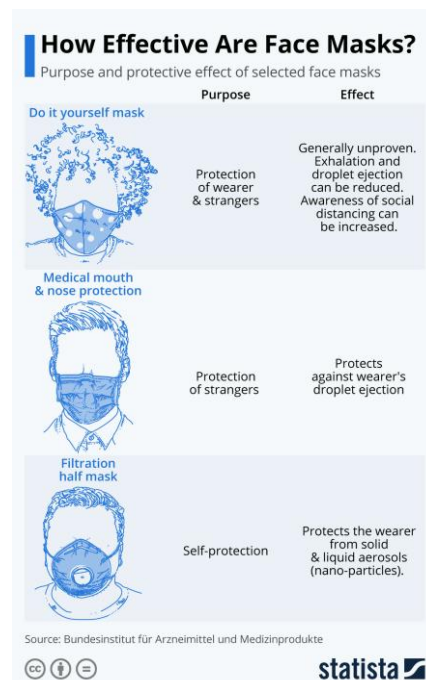


Fig 2: The comparison between different types of masks in airborne transmission (14)

The use of N95 masks should be universal in health care in situations where exposure to airborne diseases is involved (10) as it can be very helpful in the prevention of the disease. But there has been a debate in universal masking policies, where at a recent CDC HICPAC meeting most of the members did not want to support universal masking in healthcare, despite the pressure from SARS CoV 2 and also the threat of H5N1 which is also known as bird flu.(9) Some experts object by saying that surgical masks "have little place in preventing airborne transmission" and instead healthcare professionals should always wear N95 respirators when being exposed to patients with respiratory diseases. (9)

Source Control

Source control is the use of masks and respirators by the infected person to prevent the infection from spreading to others. This is very important for people who might be contagious but are not aware or don't have any of the symptoms. In settings that are high risk, like quarantines and transport situations, universal use of masks and respirators like N95 are recommended(2). The precautionary principle is that in situations where pathogens are documented going from person to person spread with severe outcomes, the initial conclusion should be that it is an airborne risk unless evidence says otherwise.(6)

The Updated Clinical Guidelines

The new 2025 AORN guidelines for transmission-based precaution reflect lessons learned from reflecting from the covid 19 pandemic. The updates include these key points:

Physical distancing is important and has been updated from the old three feet distance to as "much distance as possible", reflecting that airborne pathogens travel far further than believed they used to.

Studies show that intubation and extubation are much safer than a voluntary cough as it makes the patient generate fewer airborne particles, and the droplets travel less far. Now the focus has shifted from labeling procedures like AGP or Non-AGP to actual individualized risk assessment

The new guidelines highlight that people respond coordinated and proactively to newly emerging pathogens and viruses. Things like screening, distancing, testing, isolation, and decision about postponing elective procedures. (1)

Ventilation And Air Quality in Airborne Disease Prevention

Why Does Ventilation Matter?

Good ventilation is important because it is essential for maintaining healthy environments and protecting people in the room from inhaling the pathogens from long range airborne transmission. (3) When indoors the concentration of the airborne virus is often higher than being outdoors, which increases the amount of exposure to the respiratory virus suspended during long range transmission. Protective indoor ventilation practices can reduce the viral dose of the virus suspended in the air and lower the amount of dose exposed to other people in the room. (3)

Ventilation in prevention of disease has several components (5):

The introduction of the outdoor air

The indoor air movement and the diluting of the suspended pathogens

Filtering the air with HVAC systems and air cleaning in the room

Air treatment with GUV systems

Strategies Related to Ventilation

If there is a lower concentration of the virus pathogens in the room, this will result in fewer of those virus pathogens inhaled by the people in the room, which lowers the viral dose a person will inhale. (5) It is not known how much the concentration of the virus pathogens in the room must be reduced to start reducing the infection risk; it is still a good approach to reduce the risk of getting sick (5). A person can approach this strategy by doing these: (5)

Individuals can increase the outdoor air supply as this dilutes the virus concentration, thus reducing the viral dose they inhale

People can upgrade the filtration in the room by using MERV 13 or higher filters in HVAC systems

By using portable air cleaners like HEPA filters which effectively remove particles from the room air

GUV/Germicidal Ultraviolet is a technology that kills airborne pathogens

Building owners are usually encouraged to implement multiple strategies at the same time to increase the overall effectiveness of the strategies. (5) In the CDC's "Clean Air Buildings Challenge" gives people a framework to improve indoor air quality to reduce the risk of airborne disease.

Ventilation In Different Settings

In healthcare settings often have specific ventilation requirements to prevent and control the infectious viruses. (5) These requirements should be followed, and when the ventilation rates are lower than the requirements, building owners are encouraged to implement more protective guidance.

In schools, most classrooms usually rely on natural ventilation, which often doesn't meet the indoor air quality standards, especially when the classroom is fully occupied (8). Mobile air cleaners give effective protection against the long-range transmission from the airborne diseases at room scale when they are appropriately selected and where they are positioned. And people can also use personalized air cleaners to dilute the short-range exposure. (8)

In public transportation like trains and buses are areas where individuals can also apply ventilation improvements to lower the spread of airborne diseases (3)

Precautionary Principle

There was a debate over airborne disease that was highlighted during the recent Hantavirus outbreak (6). Experts debate that the WHO's default response to new virus outbreaks should change. They say that for pathogens with person to person spread and with severe outcomes, people should first assume it is an airborne risk unless there is evidence proving otherwise. They argue that the burden of proof should not be on the individuals who want to be cautionary but the individuals who argue to relax the precautions. (6)

Organizational Preparedness

Precautions On Transmission

Healthcare organizations should enforce standard precautions for all the patients and transmission-based precautions when indicated (1)

Some precautions are:

Select and use the appropriate PPE

Standard precautions for every patient

Droplet and airborne precautions

Patients under the droplet and airborne precautions should usually be in single patient rooms and transport should be minimal (1)

Newly Emerging Infectious Disease Planning

The Covid-19 pandemic showcased what the need was for proactive and coordinated responses to new pathogens. (1) For an effective emerging disease plan needs to include some measures to identify, isolate and control the airborne transmission while giving safe care to the patients. This plan includes :(1)

Effective communication and coordination between the interdisciplinary team

Following screening and isolation protocols

Testing strategies

Decisions in whether to postpone elective surgeries and procedures

Layering The Approach

Most experts agree that masks alone do not give adequate protection, and instead a multi-part approach is better like including ventilation, source control and respiratory protection all at the same time (10). As the viral dose is decreased through multiple prevention strategies gives a more robust and strong defense rather than relying on a single component of the strategy.

These key components of the strategy are:

Vaccinations and Hygiene

Source Control by masking the person who is infected

Respiratory protection with respirators like N95 for people working in healthcare

Physical distancing as much as possible

Ventilation and air cleaners

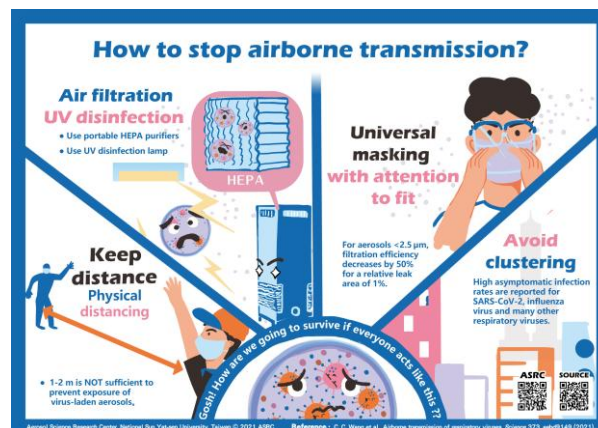


Fig 3: An infographic showing how you can reduce the chance of airborne transmission

Why Is It a Challenge to Implement?

Implementing these practices has several challenges as some healthcare facilities have cost and resource constraints, staffing shortages, and resistance to masking policies. (9) In healthcare settings, maintaining a 6-month supply of respirators at pandemic usage levels is strongly recommended to ensure preparedness of the hospital. (1)

There is an ongoing debate about universal masking. Some people argue that healthcare facilities like hospitals should implement policies allowing healthcare workers to wear respirators voluntarily, like workers who have immunocompromised or at-risk relatives at home. (9) Other people say that the use of respirators is burdensome and should only be used in very high-risk situations. Evidence and Research tells us that using respirators as somewhat of a precautionary approach and emphasizing its use where airborne exposure is possible is the most protective.

The Impact of The Different Fields

In Healthcare

The use of airborne disease prevention has impacted healthcare significantly as many hospitals have invested in buying and upgrading HVAC systems, implementing universal respirator policies, and making comprehensive plans for the newly emerging diseases. These changes can not only protect the health care workers in the hospitals, but also patient safety and less healthcare associated infections. (1) Even the integration of telemedicine and remote monitoring in current day hospitals has decreased the chance of airborne disease transmission.

In Education

Schools have implemented ventilation strategies, like the use of portable air cleaners and the upgraded filtration systems (8). Many institutions have also implemented policies encouraging students, teachers, and staff to stay

home if they are sick. These measures have reduced respiratory disease outbreaks in these educational settings, which improves the attendance of the staff and students.

In Workplaces

Places like offices have been investing in indoor air quality improvements. They recognize that the healthier air quality leads to less absenteeism and more productivity during work hours. During pandemics and peak respiratory virus seasons, businesses are implementing flexible work policies like online or remote work, and recently these policies have become more common. These policies represent a shift in the improvement of health in workplaces and safety standards.

Public Health Policies

Policymakers have implemented updated guidelines in airborne disease prevention, which reflect the lessons learned from the COVID 19 pandemic. The World Health Organizations' new updated terminologies and the CDCs ventilation guides represent the advancements made in public health policies. (3)(10) These updates by policy makers have influenced places like health care regulations, building codes and emergency preparations planning in the government.

Recommendations For Future Research

While significant progress has been made on preventing and understanding airborne disease, there are still areas that need more research for example:

Ventilation Standards in Different Situations

Research in the future should be focused on establishing ventilation standards in different areas like schools, offices, and hospitals. The current standards are based on limited research that is available, and people need more research to come to determine what the different optimal ventilation rates are for the number of occupants and the activities in the room. (5)

Respirator Effectiveness in Different Scenarios

There is more research needed to evaluate the effectiveness of respirators like N95 in the real world and in different settings. N95 respirators have been proven to be highly effective in settings that are controlled. But there is more research needed in real world healthcare and different community settings (10).

Interventions In Behavior

A critical research priority is understanding how to promote prevention behaviors like vaccination, staying home when sick and hand washing/sanitizing often. Behavioral science research can help develop a more effective way to word public health messaging and interventions. (4)

New And Emerging Technologies

New technologies like upgraded air cleaning systems, wearable air quality monitors, and improved respirators offer promising opportunities for respiratory transmission preventions. More research is needed to test the effectiveness and how cost-effective these upcoming technologies are.

The Conclusion

Airborne diseases present a unique challenge as the disease pathogens can remain suspended in the air and travel long and short distances. Preventing the spread of these diseases can be hard and needs a comprehensive and multi layered plan.

The best layers in the plan can be summarized here:

For Individuals

Stay up to date with the latest recommended immunizations/Vaccinations

Practice good hygiene like handwashing, sanitizing, and surface cleaning.

Stay home from work or school whenever sick

Consider wearing a mask in high-risk settings, like when near vulnerable individuals

For Healthcare and in the Workplace

Implement respiratory protection programs with respirators for healthcare workers when exposed to airborne pathogens

Improve ventilation by increasing outdoor air, improving filtration and implementing air cleaning technologies

Adopt the updated transmission-based guidelines (1)

For Organizations

Apply the precautionary principle that says whenever dealing with a novel virus that has a person to person spread with severe outcomes, assume that the spread is airborne until evidence proves otherwise

Invest in air quality improvements and the ventilation infrastructures to dilute the suspended pathogen in the air

Always maintain a supply of high-quality respirators in case of emergency

Always provide clear and evidence-based guidance that highlights layered protection and prevention (6)

No single intervention in prevention is sufficient to prevent airborne disease effectively. The most effective strategy combines all the components like vaccination, personal hygiene, respiratory protection, ventilation and organizational preparedness into one detailed strategy. The WHO's new update in terminology highlights that airborne disease transmission happens across a range of particle sizes, and prevention of transmission must address

the long range and short-range transmission. (10). By implementing these strategies communities can help reduce the risk of airborne disease significantly and protect the public health.

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