Five Steps for Dramatically Reducing the Number of COVID-19 Infections and Deaths in Veteran Administration Hospitals and Homes

by James A. Marusek

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Step 1: Control Relative Humidity Levels Within the Facilities between 40% and 60%

This initial step was derived from a research study by a practicing pediatric oncologist, Dr. Stephanie Taylor, who analyzed the variables associated with infectious control and localized one of the prime infection variables – indoor relative humidity. The findings were discussed in the following article: *This Inexpensive Action Lowers Hospital Infections And Protects Against Flu Season*.[1]

> While practicing pediatric oncology at a major teaching hospital, Taylor wondered why so many of her young patients came down with infections and the flu, despite the hospital's herculean efforts at prevention. Her hunch: the design and infrastructure of the building contributed somehow.
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> She and colleagues studied 370 patients in one unit of a hospital to try to isolate the factors associated with patient infections. They tested and retested 8 million data points controlling for every variable they could think of to explain the likelihood of infection. Was it hand hygiene, fragility of the patients, or room cleaning procedures? Taylor thought it might have something to do with the number of visitors to the patient's room.
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> While all those factors had modest influence, one factor stood out above them all, and it shocked the research team. The one factor most associated with infection was (drum roll): dry air. At low relative humidity, indoor air was strongly associated with higher infection rates. "When we dry the air out, droplets and skin flakes carrying viruses and bacteria are launched into the air, traveling far and over long periods of time. The microbes that survive this launching tend to be the ones that cause healthcare-associated infections," said Taylor. "Even worse, in addition to this increased exposure to infectious particles, the dry air also harms our natural immune barriers which protect us from infections."
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> Since that study was published, there is now more research in peer-reviewed literature observing a link between dry air and viral infections, such as the flu, colds and measles, as well as many bacterial infections, and the National Institutes of Health (NIH) is funding more research. Taylor finds one of the most interesting studies from a team at the Mayo Clinic, which humidified half of the classrooms in a preschool and left the other half alone over three months during the winter. Influenza-related absenteeism in the humidified classrooms was two-thirds lower than in the standard classrooms—a dramatic difference. Taylor says this study is important because its design included a control group: the half of classrooms without humidity-related intervention.
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> Scientists attribute the influence of dry air to a new understanding about the behavior of airborne particles, or "infectious aerosol transmissions." They used to assume the microbes in desiccated droplets were dead, but advances in the past several years changed that thinking. "With new genetic analysis tools, we are finding out that most of the microbes are not dead at all. They are simply dormant while waiting for a source of rehydration," Taylor explained. "Humans are an ideal source of hydration, since we are basically 60% water. When a tiny infectious particle lands on or in a patient, the pathogen rehydrates and begins the infectious cycle all over again."

> These findings are especially important for hospitals and other health settings, because dry air is also associated with antibiotic resistance, which can devastate whole patient populations. Scientists now believe resistant organisms do not develop only along the Darwinian trajectory, where mutated bacteria produce a new generation of similarly mutated offspring that can survive existing antibiotics. Resistant pathogens in infectious aerosols do not need to wait for the next generation, they can instantly share their resistant genes directly through a process called horizontal gene transfer.

The bottom line from her research is that to control viral and bacterial infections (including coronavirus infections) in hospitals and other indoor settings, an inexpensive approach is to maintain these indoor settings within the "sweet spot", the range of 40 to 60 percent relative humidity.

These findings are supported by a recent article in the Annual Review of Virology in a paper titled *"Seasonality of Respiratory Viral Infections"*. [2]

> The term seasonal infection associates a specific infection with a distinct season of the year. Consequently, the perceived relationship between infections and seasonal climate is considered to be causal. This was accurate to some extent when humans lived and worked outdoors with minimal protection from even the most severe climate conditions. The industrial revolutions changed all this. Outdoor agricultural workplaces were relocated into factories and offices, moving human lifestyle away from nature and outdoor climate. With the widespread introduction of central heating and increasingly airtight, insulated building shells, a consistent thermal comfort zone could be maintained indoors, causing even further disconnection from daily and seasonal outdoor climate fluctuations. This disconnection is particularly evident in winter, when indoor heating causes a major divergence of indoor and outdoor temperature and relative humidity (RH).
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> In the industrialized world, most people interact, work, sleep, commute, and spend 90% of their lifetime in enclosed spaces, where they share a limited amount of breathing air. This implies that the overwhelming majority of person-to-person transmission events happen indoors. The multiple factors described in Figure 1 modulate the spatiotemporal onset and progression of seasonal respiratory viral infections. With this in mind and focusing on temperate regions, we discuss the importance of environmental factors on the transmission of respiratory viruses and the host immune response.

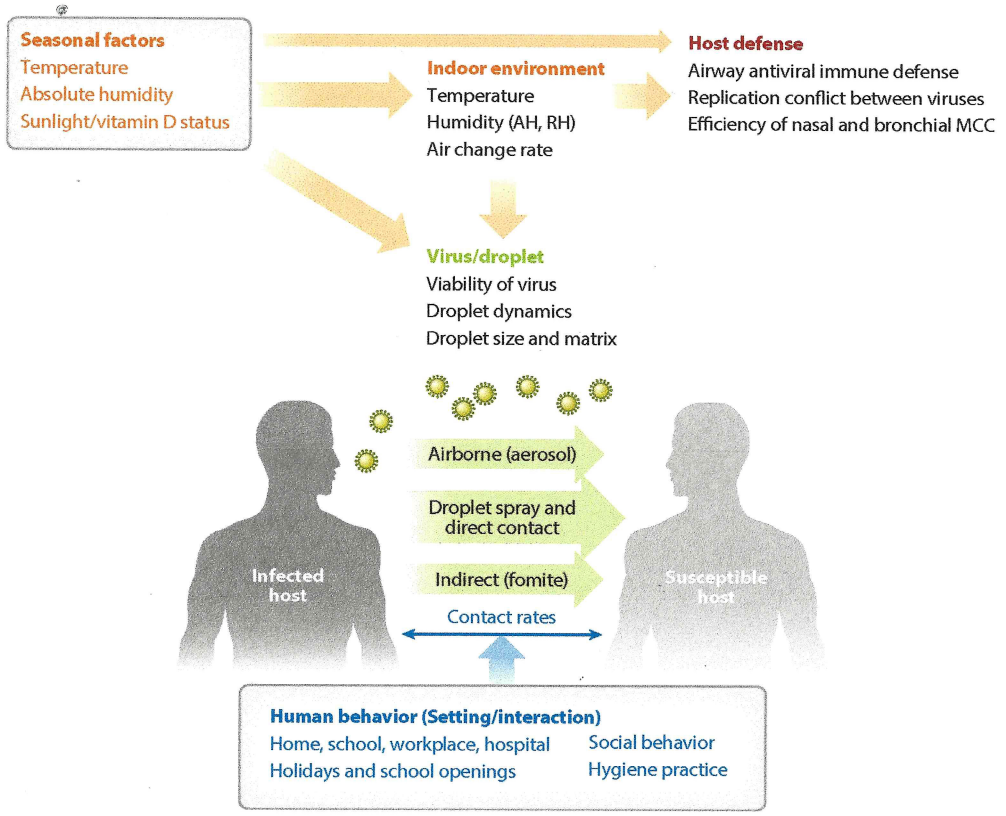


Figure 1

Factors that affect respiratory virus transmission. Seasonal environmental factors modulate host airway immune responses and affect viability and transmission ways of respiratory viruses. Human behavior affects the contact rates between infected and susceptible individuals. Abbreviations: AH, absolute humidity; MCC, mucociliary clearance; RH, relative humidity.

There are numerous findings in current literature that correlate the viability of influenza virus, suspended within the droplet matrix, with the degree of droplet evaporation and the associated supersaturation of the enclosed ingredients. The state of vapor equilibrium in room air, expressed as saturation ratio or RH, affects all infectious droplets with respiratory viruses, independent of their source (respiratory tract or aerosolized from any fluid) and location (in air or settled on surfaces). RH therefore affects all transmission ways but has the most pronounced effect on airborne transmission. Animal transmission studies with guinea pigs and ferrets have revealed that the equilibrium state in high RH (>60%) and low RH (<40%) seems to allow viability of influenza viruses in droplets, while in intermediate RH (40% to 60%) viruses become inactivated (Table 1).

Table 1 Droplet transmission under different relative humidity conditions

Climate/season	Outdoor absolute humidity	Indoor relative humidity (%)	Respiratory virus stability	Proportion of droplet nuclei	Viability of respiratory viruses	Predominant transmission
Tropical	High	60–100	High	Low	High	Fomite, direct and indirect contact
Temperate: spring, fall	Intermediate	40–60	Low	Low	Low	All transmission ways possible
Temperate: winter	Low	10–40	High	High	High	Predominantly airborne

> Lowen & Palese predict that aerosol transmission predominates during the winter season in temperate regions (because dry and warm indoor climate allows stability of influenza viruses in desiccated droplet nuclei that stay airborne for prolonged periods), while contact is the major mode of spread in the tropics (because in warm and humid climates, droplets evaporate less water and readily settle on surfaces). This hypothesis is illustrated in Table 1 and has considerable effect on proper precautions and public health measures against respiratory virus infections in different parts of the world and in different seasons.

Additionally, humidity also affects the human immune systems performance.

> The intrinsic barrier provides the first line of defense against respiratory viruses on the mucosal surface of the respiratory epithelium. The mucosal surface of the respiratory tract is continuously exposed to inhaled environmental air containing volatile and nonvolatile pollutants and potentially various pathogens. Multi-tiered host airway defense systems prevent infection by incoming respiratory viruses. Seasonal fluctuations of temperature and humidity of the inhaled air have been shown to directly affect the airway mucosal surface defense at multiple levels (Figure 3).

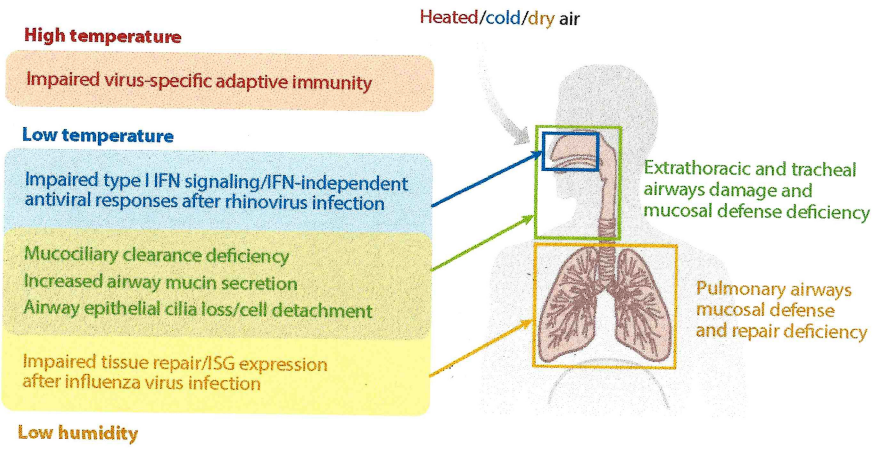


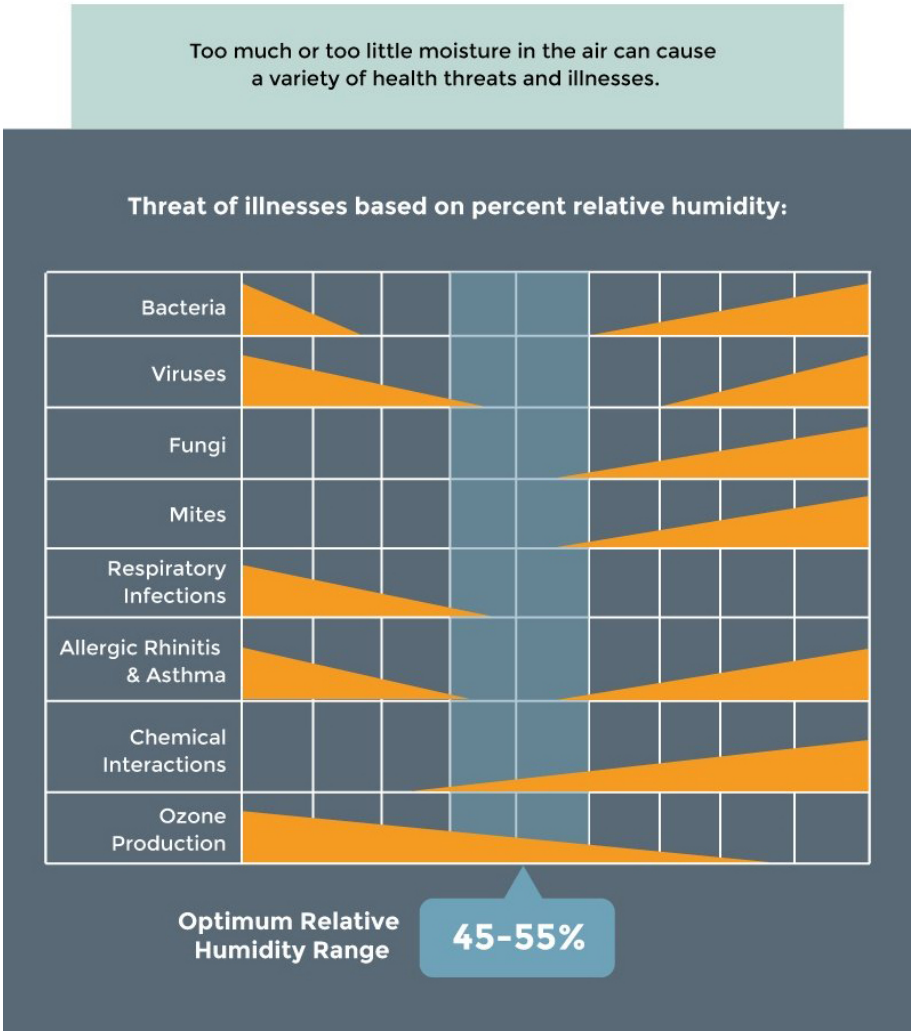
Figure 3

Effect of environmental factors on the host airway defense mechanisms. The extrathoracic and tracheal mucosal surface defense is directly affected by the seasonal changes in temperature and water content of the inhaled air on both infected and susceptible hosts. The immunological part of this effect extends into the lung periphery and lung tissue for unknown reason. Abbreviations: IFN, interferon; ISG, interferon-stimulated gene.

One of the **bottom lines** from this paper is in order to limit respiratory virus transmission in winter, humidify indoor air to maintain relative humidity levels between 40-60% at room temperature.

The approach of using humidification to minimize viral transmissions is fairly common knowledge among the building trades. The following graphs was created by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

Effect of Relative Humidity on Virus Transmissibllity.[3]



Some might argue that the COVID-19 is a novel coronavirus and not like other coronaviruses or influenza viruses. So maybe it is time to remove the novel from the coronavirus. This particular coronavirus is a seasonal virus. In general, these viral infections roar into existence during the cold winter months when humidity levels are at their lowest and then die in the spring when humidity levels return back to normal. The Department of Homeland Security (DHS) has shown that to be the case.

The Science and Technology group within DHS has been performing tests on live COVID-19 viruses in an advanced bio containment lab in Maryland, just outside the national Capital. They presented their research findings at the daily White House briefing a few days ago. Bill Bryan, the head of the science and technology directorate at the Department of Homeland, said that solar light along with high temperatures and humidity have a “powerful effect” of creating environments less favorable for the virus to survive.

Increased temperature, humidity, and sunlight are detrimental to SARS-CoV-2 in saliva droplets on surfaces and in the air

WH.GOV

CONDITION	*Temp*	*Humidity*	*Solar*	HALF LIFE
Surface	70-75°F	20%	None	18 hours
Surface	70-75°F	80%	None	6 hours
Surface	95°F	80%	None	1 hour
Surface	70-75°F	80%	Summer	2 minutes
Aerosol	70-75°F	20%	None	~60 minutes
Aerosol	70-75°F	20%	Summer	~1.5 minutes

A chart released by during the White House coronavirus task force by the DHS showed that the novel coronavirus dies within two minutes in hot summer humidity while on surfaces and a minute and a half while in the air. "Coronavirus dies at a much more rapid pace when exposed to sunlight and humidity," Bryan said during the White House briefing. "The virus dies the quickest in direct sunlight.[4]

So what does this mean? The COVID-19 coronavirus will die off as the humidity levels rise in the spring. Sunlight and especially far ultraviolet light (UVC) component rapidly kills the virus. COVID-19 is a seasonal infection similar to that of the influenza virus.

To implement this finding, two elements are required. The first is an inexpensive but accurate temperature/humidity thermometer so you can measure the indoor humidity levels and the second is a means of controlling indoor humidity levels. A humidifier is normally used to interject moisture into the low humidity air. A dehumidifier or air conditioner is normally used to remove excess humidity from the air. This photograph shows a low cost temperature/humidity thermometer.

Step 2: Install UVC Sanitizers in HVAC Ductwork

One of the points I found very interesting in the article on Dr. Taylor's research was "Scientists attribute the influence of dry air to a new understanding about the behavior of airborne particles, or "infectious aerosol transmissions." They used to assume the microbes in desiccated droplets were dead, but advances in the past several years changed that thinking. "With new genetic analysis tools, we are finding out that most of the microbes are not dead at all. They are simply dormant while waiting for a source of rehydration," Taylor explained. "Humans are an ideal source of hydration, since we are basically 60% water. When a tiny infectious particle lands on or in a patient, the pathogen rehydrates and begins the infectious cycle all over again."

So consider for a moment that there exist three modes of transmission for the virus. Originally we were told that when an infected person coughs, sneezes or talks, they spray the air with large respiratory mucus droplets, which falls to the ground or on tables or shelves or other objects. We then touch these and then touch our mouth or nose and contaminate ourselves. Thus if we maintain a 3 foot social distance we are safe and wash our hands a million times per day with soap and water to stop the spread. But that was not true. Because when a person coughs they also spread very fine moist aerosols that can travel up to 15 feet, so maybe wearing a face mask might be beneficial after all. But that is not totally accurate either. There is another form of transmission, a third form. [I feel this is a predominant form that is commonly overlooked] Viruses are not living things; they need a host - a living human body to replicate. In a low humidity environment, a virus can dry out and when they become desiccated they become very light and can become airborne and travel great distances (perhaps 100 feet). [Think of a room with a layer of feathers on the floor. The slightest breeze or motion will lift the feathers up into the air and allow them to float. But if you take a garden hose and water down the feathers, they are heavier and cling to the ground.] These desiccated airborne virus cells float through the air looking for a host. You walk along and take a deep breath and pull some into your moist wet throat. They rehydrate and begin to reproduce infecting the host.

In my humble opinion, these airborne desiccated virus cells can be sucked into Heating, Ventilation and Air Conditioning (HVAC) systems and concentrated to produce enhanced viral loads. So is there any evidence this is occurring?

Concerns that COVID-19 can spread through the air have increased after researchers in Wuhan, China discovered the genetic material of the coronavirus in airborne droplets in two hospitals, according to a new study. The research, published in the scientific journal Nature, found the virus' ribonucleic acid (RNA) in different areas of the two hospitals in February and March. Although the RNA discovered in isolation wards and ventilated patient rooms were "very low," there was an "elevated" level in patients' toilet areas, the researchers found. "Although we have not established the infectivity of the virus detected in these hospital areas, we propose that SARS-CoV-2 may have the potential to be transmitted via aerosols," the researchers wrote in the study's abstract.[5]

In March, a joint study by the University of Nebraska Medical Center, the National Strategic Research Institute at the University of Nebraska, and others found genetic material from the virus that causes COVID-19 in air samples from both in and outside of confirmed coronavirus patients' rooms. The findings offer, "limited evidence that some potential for airborne transmission exists."

A newly published research letter suggests that three healthy families in China may have contracted the coronavirus virus after it traveled via air conditioning at a restaurant that also served infected people. The early-release research letter, which will be published in the Emerging Infectious Diseases journal in July,

notes that 10 people from 3 different families were affected during the period of Jan. 26-Feb. 10, 2020, at a restaurant in Guangzhou, China. Those who became infected were a result of where they sat in the restaurant, which was in relationship with strong airflow from the air conditioner. They found that the other 73 patrons were not affected.[6]

Bill Bryan, chief of the science and technology directorate at the U.S. Department of Homeland Security indicated, "Our most striking observation to date is the powerful effect that solar light appears to have on killing the virus [COVID-19], both on surfaces and in the air." Bryan explained the mechanics of the COVID-19 temperature tolerance experiment in simple terms. "We're able to take a particle of a virus and suspend it in the air inside of this drum and hit it with various temperatures, various humidity levels, multiple different kinds of environmental conditions to include sunlight. And we're able to measure the decay of that virus while it's suspended in the air. This is how we do our aerosol testing". He said in a room at 70-75ºF temperatures with 20 percent humidity, the half-life of the virus is about an hour. "But you get outside and it cuts down to a minute and a half, very significant difference when it gets hit with UltraViolet (UV) rays". Bryan said the DHS bio containment lab is the only one in America that has the capability to do the kind of testing that has led to the research on the virus' UV and temperature tolerance.[7]

Far UltraViolet (UVC) radiation (100nm-290 nm) has germicidal properties. UVC light is well known to possess a very powerful germicidal effect capable of inactivating a wide spectrum of microorganisms, such as viruses, bacteria, protozoa, fungi, yeasts, and algae, through the formation of pyrimidine dimers, the photoproducts of genetic materials.

Bacteria and viruses are of micrometer or smaller dimensions; UVC can penetrate and inactivate them. For example, research studies on influenza virus demonstrated that UVC radiation can efficiently inactivates airborne aerosolized viruses, with a very low dose of 2 mJ/cm^2 of 222-nm light inactivating >95% of aerosolized H1N1 influenza virus.[8]

Scientific studies show that the majority of infections are occurring indoors and not outdoors. The infections are being passed indoors. But that problem is not difficult to solve. There is a simple cheap solution that exists. It is installing UVC sanitizers into the HVAC ductwork. It kills any airborne viruses passing through the ductwork.

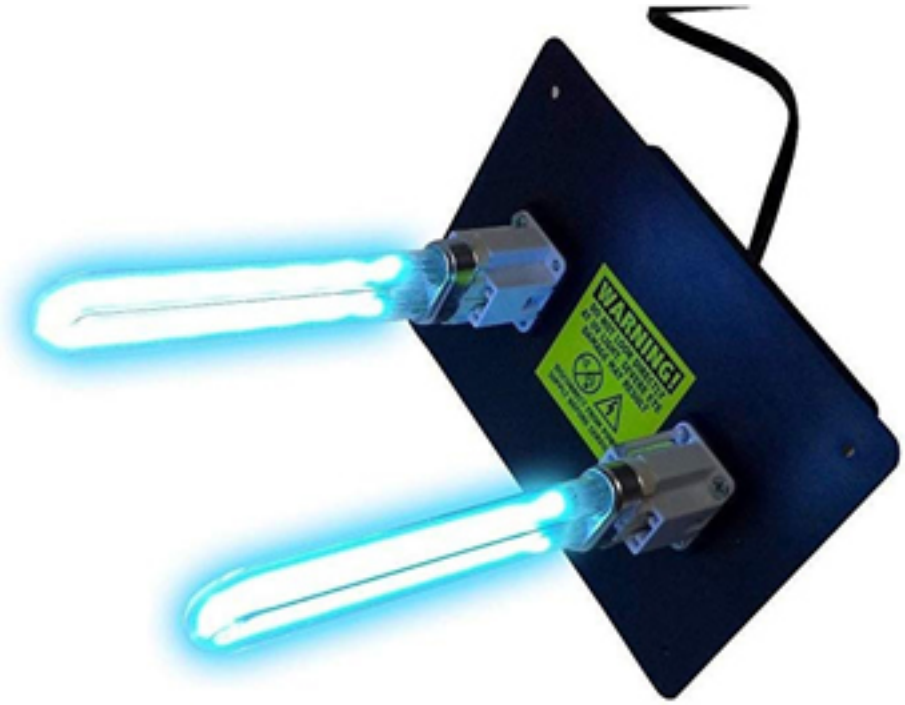
So the second step is to kill the microbes freely moving about in the air using ultraviolet light. This can be done using off-the-shelf far ultraviolet (UVC) technology that has been around since mid-20th century. It is commonly referred to as ultraviolet germicidal irradiation, (UVGI) technology.

Some homes and business currently are equipped with this technology built into their HVAC (heating, ventilation, and air conditioning) systems. Ultraviolet light can eliminate many types of fungi, bacteria, germs, viruses and pathogens. This dramatically reduces the level of the viruses within buildings.[9]

The goal of such UV tools isn't to kill every virus. The human body has a built-in immune system that deals with most of the threat. But it is important to not overload the immune system and allow the body time to develop the antibodies that will be needed to provide protection. So basically the desire is to

minimize the exposure level. This technology will reduce the number of viruses by a number of orders of magnitude so that the remaining viruses can be killed by the immune system.

This is an example of the technology. This product is in the $90 price range. It is designed as an add-on to an existing HVAC system.



The product description reads: *All our units have electronic ballast and have a sight glass to see if unit is on. All our bulbs are germicidal UVC and put out 253.7NM, which means that they are 99% efficient on a single pass. Installation is very easy 15 min, just cut 2 holes of 1 inch in your ductwork (template included) slip the lamp inside and attach the aluminum strips (included in box) and plug it in, 9 ft cord.*

But some VA hospitals and homes may lack HVAC system. There are alternatives. There are a variety of stand-alone air purifiers on the market and some are equipped with UVC sanitizers. Some of these air purifiers have HEPA air filters that filter out 99.97 percent biological material efficient down to 0.3 microns of particle size, similar to an N100 face mask. But then they combine this with UVA system that destroys airborne bacteria, mold spores, and viruses. Other air purifiers incorporate the array of HEPA, Ionic, UV and Carbon filters.

My house does not have a centralized HVAC system. So I purchased a stand-alone air purifier from my home. I wanted something that incorporated UVC but otherwise I wanted something pretty bare bones. I wanted something that was extremely quiet so it would not interrupt my sleep. HEPA filters generally are not quiet units. A bare bones unit will also require minimal electricity. This can become important in a large facility because putting several online at the same time could cause existing circuit breakers to blow.

So I went out and ordered a small unit so I could experiment with it. Put an order in *Amazon* on Monday and it arrived on Friday. It is small enough that it could easily fit next to my desk at work and not blow a circuit breaker in the process.

It is a small little unit. I put a Coca-Cola glass next to it for size comparison. The unit includes an electrostatic collecting, ozone filter and activated carbon filter, powerful UV lamp and a negative ionizer. It uses very little electricity to operate - 600 milliamps. The fan is whisper quiet. I have been using it for over a month. I noticed that my breathing was improved when I slept. I suspect that the unit reduced some of the smoke particles from the wood stove that I use to heat my home.

To sum this up - In My Humble Opinion (IMHO), the coronavirus threat can be controlled. You have to step out of the box a little to understand the process. In a way it falls under Engineering. When people are crammed close together in cruise ships, airplanes, buses, offices, schools, hospitals, nursing homes, jails, etc. the virus is spread from one person to the next rapidly. Much of the virus contamination occurs in an indoor setting. If you can properly control the indoor environment you can minimize the transmission rates. There are two ways to dramatically lower the infection rate in the indoor environment. These are to control the indoor relative humidity levels between 40 and 60 percent. The second is to destroy the ability of the virus to infect a person. One method is to use far ultraviolet light (UVC) to destroy the virus.

Step 3: Implement Expanded Screening for Site Access

One of the problems with COVID-19 infections is the high number of asymptomatic carriers, those individuals that do not show symptoms. So it would be advantageous to expand screening for the VA hospitals and nursing homes to include a screening for symptomatic individuals (such as using a forehead infrared thermometer) along with a means of screening out asymptomatic carriers.

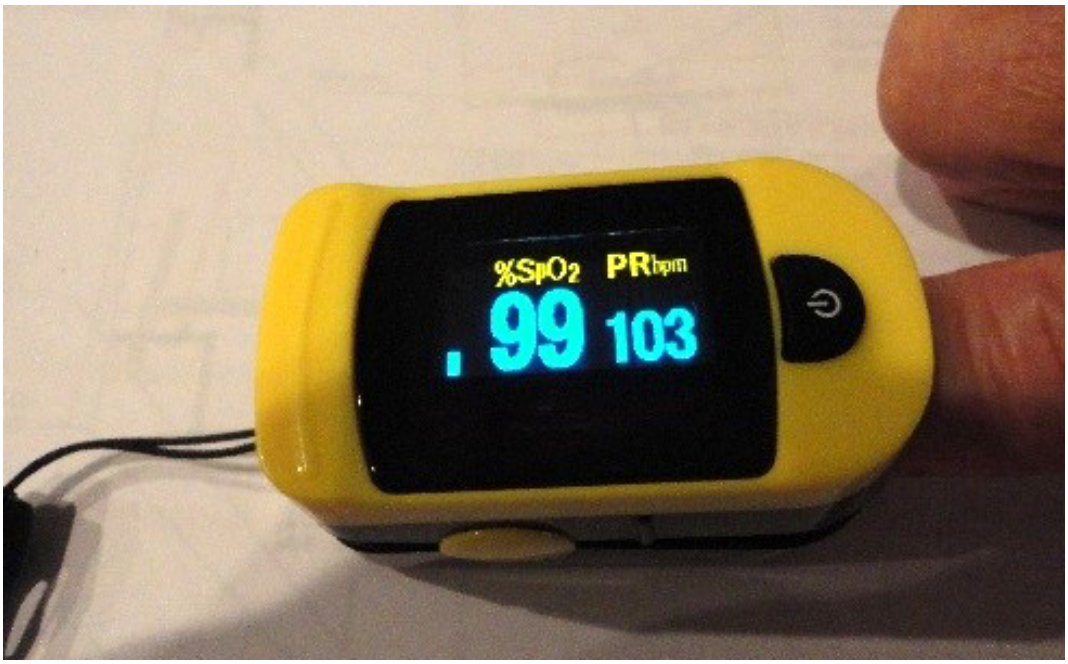
I remember back in the early days of this pandemic as the TSA tried to impose screening test at airports to keep the coronavirus out. Many times one would see an agent with a handheld infrared thermometer taking travelers forehead temperatures. But there were people who were asymptomatic, they showed no symptoms, they had no fever, but they were infected and able to pass the disease onto others. Thus the U.S. even though it tried to build a firewall against the disease was unable.

Doctors have observed a strange trend in more COVID-19 patients: people with blood oxygen saturation levels that are very low but who aren't gasping for breath. Although often quite ill, these patients are not presenting symptoms like most acute respiratory distress syndromes, which is a lung failure previously associated with the SARS outbreak in 2003 and other respiratory diseases. These types of patients are alert and feeling relatively well, but their lungs are not performing their proper function. This presentation is known as "silent hypoxia" and it's causing some people to arrive at the hospital in worse health than they realize. Silent hypoxia progressing rapidly to respiratory failure explains cases of COVID-19 patients dying suddenly despite not feeling short of breath.[10]

Silent hypoxia sounds very similar to another condition called walking pneumonia. "Walking pneumonia," sounds like it could be the name of a sci-fi horror flick. But it's actually the least scary kind of pneumonia. It can be milder than the other types, and you usually don't have to stay in the hospital. You could have walking pneumonia and not even know it. Walking pneumonia is how some people describe a mild case of pneumonia. Anyone can get it. Walking pneumonia from mycoplasma is most common in children, military recruits, and adults younger than 40. People who live and work in crowded places -- such as schools, dorms, military barracks, and nursing homes -- are more likely to come into contact with it. Walking pneumonia spreads through sneezes or coughs. But it spreads slowly. If you get it, you could be contagious (which means you could spread it to other people) for up to 10 days. Researchers think it takes a lot of close contact with an infected person for a healthy person to catch walking pneumonia.

IMHO individuals with "walking pneumonia" from an influenza virus or "silent hypoxia" from a coronavirus are infected carriers capable of transmitting the infection. They are asymptomatic carriers. It would be productive to screen for these individuals and restrict them from site access. One simple method is using a pulse oximeter.

Pulse oximeters have become common in the modern world. Just as thermometers measure your temperature; pulse oximeters clamp onto your fingertip and measure the oxygen in your blood. They are available on Amazon for under $20.



The pulse oximeter, or Pulse Ox, is an electronic device that measures the saturation of oxygen carried in your red blood cells. The device uses a cold light source that shines a light through the fingertip, making the tip appear to be red. By analyzing the light from the light source that passes through the finger, the device is able to determine the percentage of oxygen in the red blood cell (SpO2); a normal reading is typically between 95 and 100 percent. However, in COPD or other lung diseases, these ranges may not apply. For example, it isn't uncommon for people with severe COPD to maintain their pulse ox levels (SpO2) between 88 to 92 percent. In most individuals a reading below 90% indicates hypoxemia—a condition in which there is a deficiency of oxygen in the blood, which is normally associated with severe pneumonia.[11]

If a person is wearing dark fingernail polish, long, artificial nails or if your fingers are not clean, the pulse oximeter may not work properly.

A pulse oximeter can be used to screen for asymptomatic carriers. Anyone seeking access to the site such as medical staff, caregivers, patients and visitors should undergo not only forehead temperature test but also pulse oximeter test.

But the test is not fool proof. I might also uncover an existing chronic lung condition. Therefore if a person has a pulse oximeter reading of 90% or below and additional screening test might also be useful.

I recently watched a video about a new test kit developed by the National Taiwan University's College of Medicine to rapidly assess lung health in 30 seconds. Developers are touting it as a cheap preliminary diagnostic tool for COVID-19. Developers say it can check lung condition and screen for the first signs of the coronavirus, long before the patient shows any symptoms. The device has a permit application pending, and developers at National Taiwan University's College of Medicine hope it will be rolled out across the country soon. They say it can even be used at airports as a fast screening for travelers entering the country. Two devices, rather like earmuffs, are placed on the sides of the abdomen. Within 30 seconds, data on the person's lung quality comes on screen. A continuous reading of six indices of lung

health, including a measure of fluid in the lungs, is produced. A warning comes up if safe levels are exceeded. It can be used to test for standard pneumonia and lung cancer. Developers believe it can also serve as a new preliminary screening for COVID-19. Prof. Lin Shih-ming of NTU College of Medicine stated our current screening methods are all nucleic acid tests. It's not possible to be sure if the virus has entered the lungs. We can compare our data to an X-ray and see whether the lungs have the "frosted glass" pattern typical of COVID-19. The portable device was assembled at NTU College of Medicine's Institute of Medical Device and Imaging. Variations in electromagnetic frequency are used to swiftly assess the health of a patient's chest. Developers say the brief test can indicate if there's excess fluid in the lungs, even if no COVID-19 symptoms are presenting. Further tests then provide more precise diagnoses. As a non-invasive device that consumes negligible resources, one piece costs just NT$750 [~$25.00] to produce, allowing mass distribution. It's fast. It can test both lungs in just 30 seconds, showing if there are any pulmonary infiltrates or pulmonary edema. Another thing is it can be administered indiscriminately, as a widespread, instant screening for everybody.

This is the address for the YouTube video:

https://www.youtube.com/watch?v=0W56Z2K1h9o&feature=emb_logo

Step 4: Face Masks Requirements

There are a variety of face masks and respirator masks available. They offer varying degrees of protection from the virus. An N95 respirator is a respiratory protective device designed to achieve a very close facial fit and very efficient filtration of airborne particles. The N95 masks, when properly fitted, seal closely to the face and filter out 95% of particles 0.3 microns or larger. The N95 mask effectively prevents viral spread. N95s are the most common but other types will also work. Other masks such as N99s removes 99% of particles that are at least 0.3 microns in diameter. N100s and P100s removes 99.97% of all particles that are 0.3 microns in diameter or larger.

In general, those in VA hospitals and homes represent a very vulnerable population (age, co-morbidities, weakened immune systems). When the threat of infection is present after the coronavirus has penetrated our nation's firewalls, I feel that all patients, medical staff, visitors, cleaning staff, etc. within the site should wear N95 facemask or better.

Generally these mask are inexpensive. Normally they run around $2 each when mass-produced. But during this pandemic several problems arose.
* First, the stockpile of strategic Personal Protective Equipment (PPE) including masks were fairly depleted from the U.S. federal emergency stockpile.
* Manufacture of the PPEs in many cases had been shifted offshore, primarily China. As a result procurement of masks were restricted and price gouging took place.
* In the initial days of this pandemic, I personally noticed several incidents of oriental individuals purchasing entire stocks of various types of mask from our big box stores, presumably to ship back to China. This left our commercial stocks depleted. There were stories that people were hoarding masks but from my observation and opinion, all masks were being vacuumed up from the U.S. and shipped overseas.

I suspect steps are being taken by the U.S. government to resolve these shortfalls and that quickly N95s or greater will become readily available soon. Therefore since N95s or better will be available, since they control the spread of viruses effectively, and since the population in the VA facilities are some of the most vulnerable, I feel all individuals within the VA facilities should wear these mask to control the spread.

Another problem with wearing mask is patient resistance to wearing masks. Many individuals do not wear face mask properly. They must fit over both the mouth and the nose. Having a tight seal is

important; facial hair can interfere. As a result, beards need to be shaved to obtain a proper seal. So in a way I can understand there might be some resistance to wearing N95. We can be rather ornery and headstrong at times and I don't really feel this requirement should be forced on Veterans. But most Veterans are patriotic. And perhaps one might appeal to their sense of duty. The discussion might be reframed that the coronavirus is a danger to their doctors, nurses and caregivers (many of which have died from this coronavirus) and appeal to their sense of coming to the plate and protecting those individuals who are taking care of them.

N95 masks because they have been normally inexpensive items are treated as throwaways. Use them once and then toss them. But that is the heart of another problem. As people throw them away, they need to buy replacements. Due to demand, stocks are quickly depleted. Store selves empty and they become an out-of-stock item. Try buying an N95 mask in February or March of this year even when the virus was not even endemic in the U.S. was difficult. Some people have resorted to washing the used mask in water but that destroys the mask integrity.

N95 mask can be reused, especially when used intermittently. But they will need to be properly sanitized between uses. So from my personal experience:

> Around ten years ago, I bought a box of 10 N95 masks and put them on a shelf to store away for a rainy day. The masks since they had been sitting in the garage for 10 years became very mildew. My wife refused to wear them. So I sanitized them. They were stored in a plastic bag. So I dropped a few drops of Tea Tree Oil in the bag and sealed if for a few days. Then I took the mask out and let them air out. We had one good sunny day, so I took them outside and hung them for a day in the sunlight. At this point the mildew was gone. So every time we went into the outside world, we wore these masks. Generally these masks are designed to be worn one day and then disposed of. But if the use is intermittent, they can be reused provided they don't become wet. So every time we wore the mask, I would hang them out in the sun to recondition them. It has been two months now and we are still wearing the same masks. These mask are normally inexpensive items. I think I paid around a dollar each ten years ago when I bought them.
>
> This mask will protect me (a vulnerable 71 year old) from breathing in coronavirus particles. If my hands touch a surface that contains the virus and I accidentally touch my face, the mask stops the transmission. If fine moist aerosols of the virus are released when a nearby person coughs, the mask stops those too. If the virus particles dry out in low humidity environments, become very lightweight and become airborne and travel long distances. They stop those particles also. They are the perfect masks.

Now the second item that I considered important was a means of sanitizing the mask, a way of removing all the virus particles from the mask between uses. There is a solution for that. It is called a sanitizer box. It will treat the mask with UVC light and ozone that will destroy any viruses and bacteria on the mask. These devices have been around for several years now. They commonly used to sanitize cell phones, wallets, baby pacifiers, money, keys, baby bottles, toys, beauty tools, toothbrushes, jewelry, etc. But they can also be used to sterilize the N95 mask between uses. They run around the $100 range. So I ordered one through *Amazon*. Like many other things nowadays, they are manufactured in China and it took over a month to receive it. This is what the sanitizer box looks like. It has an 8-minute decontamination cycle.

But there is another type of mask available. It is a better mask. It is called a RespoKare Antiviral Mask. These are very unique mask incorporating metal salts into the design. They will not only filter out viruses but also kill (deactivate) them at the same time. This mask is manufactured by RespoKare.[12]

It is the only face mask that has demonstrated its anti-viral properties via extensive laboratory testing on airborne viruses. Accepted formally by the FDA, they created a brand new medical device classification ("OUK") to accommodate RespoKare's innovations in infection control and respiratory protection. RespoKare Anti-Viral Mask is the first and only anti-viral mask to receive 510(k) clearance for sale in USA (May 26, 2011). This face mask will inactivate 99.99% of 18 flu viruses and 12 airborne diseases. When tested against coronavirus (SARS and MERS), the mask kills (inactivates) greater than 99.99% of those viruses within 1 minute.

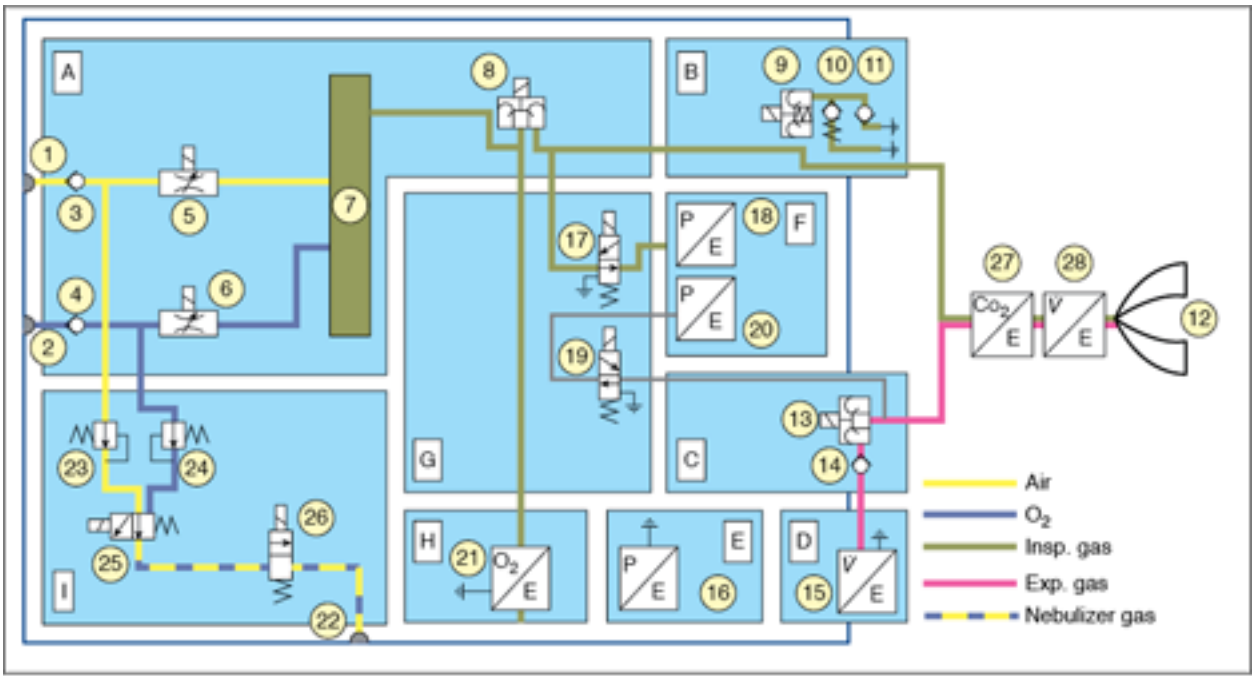
Step 5: Develop Better Ventilators

Far Ultraviolet Light (UVC) kills viruses and bacteria. Patients in hospitals often are exposed to secondary infections that kill them. These go by the name Healthcare-Associated Infection (HAI). Some patients are so weak they cannot even breath by themselves and require a ventilator. A ventilator is a machine that provides mechanical ventilation by moving breathable air into and out of the lungs, to deliver breaths to a patient who is physically unable to breathe, or breathing insufficiently. I recommend that we redesign intensive care ventilators to incorporate UVC sanitizers into ventilator construction. From my perspective this would be a simple inexpensive modification.

These photographs are examples of commonly used intensive care ventilators: **A.** Dräger Infinity V500, **B.** Hamilton G5, **C.** Maquet Servo i, **D**. Covidien PB840 [13]

In my humble opinion it is critically important to minimize the spread of viruses and bacteria both into the respiratory tract of the patient and out of the patient. This is to protect the patient from HAI infection and to protect the caregivers who support the patient. UVC sanitization is an ideal mechanism.

Source: Tobin MJ: *Principles and Practice of Mechanical Ventilation, 3rd Edition*: www.accessanesthesiology.com

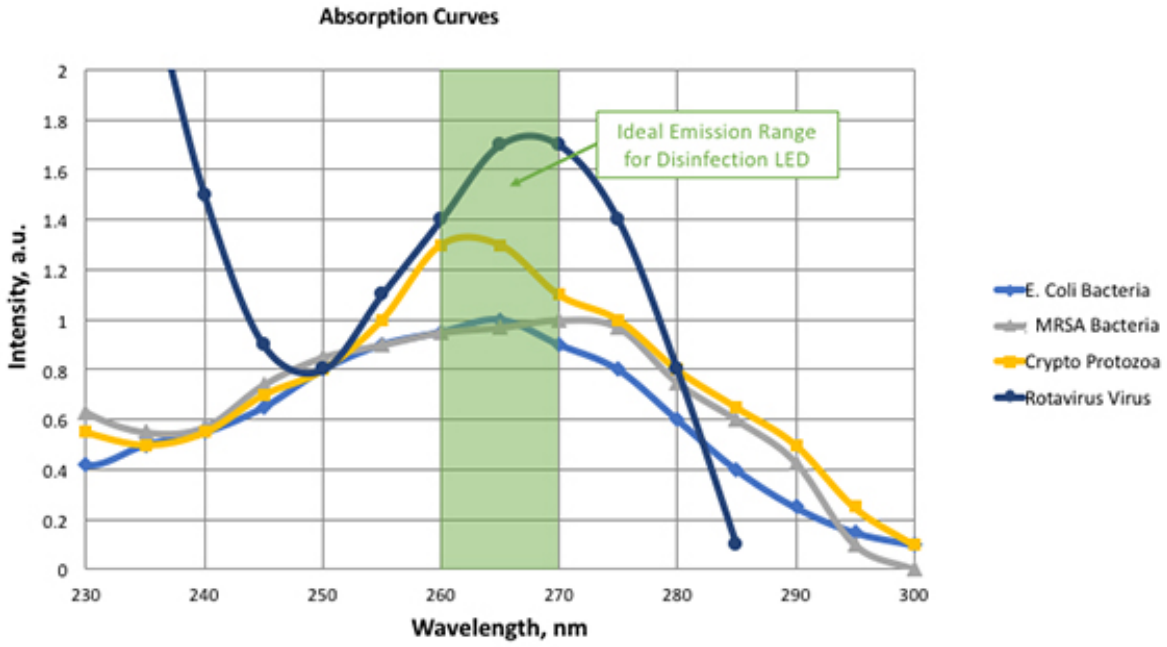


1 Air gas inlet
2 O_2 gas inlet
3 Air nonreturn valve
4 O_2 nonreturn valve
5 Air metering valve
6 O_2 metering valve
7 Tank
8 Mixed gas metering valve
9 Safety valve
10 Emergency expiratory valve
11 Emergency breathing valve
12 Patient's lungs
13 Expiratory valve
14 Nonreturn valve
15 Expiratory flow sensor
16 Barometric pressure sensor
17 Calibration valve for inspiratory pressure sensor
18 Inspiratory pressure sensor
19 Calibration valve for expiratory pressure sensor
20 Expiratory pressure sensor
21 O_2 sensor
22 Nebulizer outlet
23 Air pressure regulator
24 O_2 pressure regulator
25 Nebulizer mixer valve
26 Nebulizer changeover valve
27 CO_2 sensor
28 Neonatal flow sensor (depending on the patient category)

This is a flow schematic of a typical intensive care ventilator. In this case it is a pneumatic schematic of the Dräger Infinity V500 intensive care ventilator. **A.** Gas-mixture and gas-metering assembly. Gas from the supply lines enters the ventilator via the gas-inlet connections for oxygen and air (1,2). Two nonreturn valves (3,4) prevent one gas from returning to the supply line of the other gas. Mixing takes place in the tank (7) and is controlled by two valves (5,6). Inspiratory flow is controlled by a third valve (8). **B.** Inspiratory unit consists of safety valve (9) and two nonreturn valves (10,11). In normal operation, the safety valve is closed so that inspiratory flow is supplied to the patient's lungs (12). During standby, the safety valve is open and enables spontaneous inspiration by the emergency breathing valve (11). The emergency expiratory valve (10) provides a second channel for expiration when the expiratory valve (13) is blocked. **C.** Expiratory unit consists of the expiratory valve (13) and a nonreturn valve (14). The expiratory valve is a proportional valve and is used to adjust the pressure in the patient circuit. In conjunction with the spring-loaded valve of the emergency air outlet (10), the nonreturn valve (14) prevents pendulum breathing during spontaneous breathing. **D.** Expiratory flow sensor. **E.** Barometric

pressure sensor. Conversion of mass flow to volume, body temperature and pressure saturated (BTPS) requires knowledge of ambient pressure. **F.** Pressure measurement assembly. Pressure in the patient circuit is measured with two independent pressure sensors (18,20). **G.** Calibration assembly. The pressure sensors are regularly zero calibrated by connection to ambient pressure via the two calibration valves (17,19). **H.** Oxygen sensor. **I.** Medication nebulizer assembly. [13]

A better ventilator can prevent ventilator-associated pneumonia. UVC can also be used to address ventilator associated pneumonia (VAP). Though it occurs in only 1% to 2% percent of patients using mechanical ventilators, VAP mortality rates are greater than 50%. Focused UVC energy could disinfect complex passageways, in-vitro components and even nebulizer equipment in-situ without heating the target surfaces.[14]



REFERENCES

1. **Leah Binder**, This Inexpensive Action Lowers Hospital Infections And Protects Against Flu Season, *Forbes*, 17 Oct. 2019
2. **Miyu Moriyama**,**Walter J. Hugentobler**, and **Akiko Iwasaki**, (2020), Seasonality of Respiratory Viral Infections, *Annual Review of Virology*, 16 March 2020, 7:2.1–2.19.
3. Central Heating & Air Conditioning, [Figure based on American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), https://www.centralhtg.com/blog/managing-home-humidity-for-maximum-comfort
4. Trump, officials suggest coronavirus is weakened by sunlight and humidity https://www.foxnews.com/politics/trump-coronavirus-sunlight-heat-and-humidity
5. Coronavirus genetic material discovered in air of two Wuhan hospitals: researchers https://www.foxnews.com/science/coronavirus-genetic-material-wuhan-discovered-hospitals
6. Coronavirus may have spread via air conditioning in Chinese restaurant, researchers warn https://www.foxnews.com/science/coronavirus-spread-via-air-conditioning-chinese-restaurant
7. Sunlight, Humidity Damages Novel Coronavirus, Says the White House https://weather.com/en-IN/india/coronavirus/news/2020-04-24-sunlight-humidity-damages-novel-coronavirus-says-the-white-house
8. Welch, D., Buonanno, M., Grilj, V. et al. Far-UVC light: A new tool to control the spread of airborne-mediated microbial diseases. Sci Rep 8, 2752 (2018). https://doi.org/10.1038/s41598-018-21058-w https://www.youtube.com/watch?v=GpbUoLvpdCo
9. Separating Fact from Myth on HVAC UV Light Benefits, https://www.lincolntech.edu/news/skilled-trades/hvac/separating-fact-from-myth-on-hvac-uv-light-benefits
10. 'Silent hypoxia' may be killing COVID-19 patients, but one doctor offers a possible solution https://www.foxnews.com/science/silent-hypoxia-covid-19-patients-doctor-solution
11. World Health Organization (WHO), Coronavirus disease 2019 (COVID-19) Situation Report – 41, of 01 March 2020, https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200301-sitrep-41-covid-19.pdf?sfvrsn=6768306d_2
12. RespoKare Anti-Viral Mask, https://respokare.com
13. Chapter 3. Basic Principles of Ventilator Design, https://accessmedicine.mhmedical.com/content.aspx?bookid=520&sectionid=41692239%20
14. 3 ways to integrate UVC LEDs into medical devices https://www.medicaldesignandoutsourcing.com/uvc-leds-medical-equipment/