Airborne Influenza in Dry Wintertime Indoor Air

Is 50%rh Indoor Humidity One Cure for "Flu Season"?

Environmental Protection Agency

Federal Interagency Committee for Indoor Air Quality

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Airborne Influenza is the reason why there is a “flu season”

1. **Flu viruses are airborne and within that state are highly infectious. Airborne flu viruses penetrate deep into your lungs.**
2. **Breathing in only one to three airborne flu viruses can infect you and make you ill with severe flu.**
3. **Humidity is the critical factor in how long flu viruses can live and far they can travel. Controlling indoor humidity (grains of moisture) is one key to preventing airborne flu transmission.**
4. **Schools with “super-emitter” children are “petri dishes” for flu.**
5. **Washing your hands to prevent the flu is not very helpful.**
6. **There are plenty of solutions to prevent man-made “flu season”.**

Airborne Influenza Topics

- Current explanations for “flu” season
- How do people eject flu viruses into the air?
- How does airborne flu infect people?
- What different forms do airborne flu viruses take?
- How far can airborne flu viruses travel in a room, circulate within buildings and inside their HVAC units?
- What conditions increase airborne flu virus survival?
- What technologies are available to sterilize, capture and/or kill (inactivate) airborne flu viruses?

Three incorrect explanations for “flu season”

1. “Crowding”- people spend more time indoors so they breathe & cough in closer crowded situations creating “flu season”.
2. “Cold weather makes people sicker in the wintertime” which is around the time “flu season” occurs.
3. Low humidity, wintertime indoor air “dries up people’s mucus membranes” which allows germs to more easily infect them.

“Crowding”- people are in closer crowded situations because it’s cold outdoors

This study looked at the correlation between cold weather “episodes” when people would have to spend more time together in closer “crowded” situations, and they found no correlation to increased influenza illness.

”No consistent relations were found between various combinations of monthly mean temperatures and normalized excess deaths.”

“Confidence intervals on the number of deaths attributed to cold weather are large, so we cannot conclude that influenza is a more important cause of winter mortality on an annual timescale than is cold weather.”[1]

1. NIH Scientists Jonathan Dushoff, Cecile Viboud, et al. Mortality due to Influenza in the United States 2006 American Journal of Epidemiology v163 p181

This study is available @ GreenCleanAir.com

Cold Weather makes people sick

It's assumed that cold weather can cause you to "catch a cold". There is no science linking being cold and being more likely to be infected with a virus as a result.

"Researchers (the authors) have worked to identify and measure a seasonal component of influenza transmission with the goal of explaining large annual fluctuations in incidence. But, as we have seen here using simple models, these large fluctuations may be caused by exogenous seasonal changes in transmission that are too small to detect, amplified by the endogenous population dynamics of the host–pathogen system."[1]

In non-scientific speak: The change in seasons is not the cause of increased influenza infections.

1. NIH Scientist Jonathan Dushoff, et al. Dynamical resonance can account for seasonality of influenza epidemics 2004 PNAS v101 p16,915

This study is available @ GreenCleanAir.com

CDC's Top Influenza Scientist states that flu is Airborne

Dr. Nancy J. Cox Director of CDC Influenza Division

"It is generally accepted that influenza viruses are spread primarily by aerosols* of virus-laden respiratory secretions that are expelled into the air during coughing, sneezing, or talking by an infected person."[1]

"School Absenteeism due to influenza often occurs early in the epidemic and children are believed to play an important role in disseminating the virus into the community during both epidemics and pandemics."[2]

1. Cox, N GLOBAL EPIDEMIOLOGY OF INFLUENZA: Past and Present 2000 Annu. Rev. Med. v51 p407
2. Cox, N Fukuda, K Influenza Chapter 1999

*Droplet Nuclei are aerosols and are 5-10 microns which can stay airborne indefinitely. Even aerosols less than 20 microns can stay airborne for long periods of time. Aerosols are Not Large Droplets which are greater than 20 microns and are easily captured by the nose. Large droplets can travel 3-6 feet (via a sneeze) but quickly fall to the ground preventing them from being breathed in.

Expert Flu Virologist Professor Dr. John J. Treanor describes Airborne Flu Transmission

“Influenza virus infection is acquired by a mechanism involving the transfer of virus-containing respiratory secretions from an infected to a susceptible person. A number of lines of evidence indicate that small particle aerosols are the predominant factor in such person-to-person transmission.

The explosive nature and simultaneous onset in many persons suggest that a single infected person can transmit virus to a large number of susceptible persons.”

Dr. John J. Treanor, Chapter 162, Influenza Virus

This open source study is available @ GreenCleanAir.com

CDC Flu Expert Dr. Jacqueline Katz- Author of: ”Influenza A virus transmission: contributing factors and clinical implications”

- **“The infectivity of airborne virus in small respiratory droplets- approximately <5 micrometers (1 millionth of a meter) in diameter can be very high: the infectious dose of influenza virus in humans following aerosol inhalation was reported to be as low as three (from .6-3 viruses) 50% tissue culture infectious doses (TCID50).”**

- **“Smaller particles (<5 μm in diameter, or droplet nuclei) are capable of remaining suspended in air for longer durations of time and can be carried farther distances than large droplets, depending on the rate of particle desiccation and other environmental factors. Particles of this size are capable of penetrating deep into the respiratory tract following inhalation, which is generally not the case for inhaled large droplets.”**

Jacqueline Katz et al. Influenza A virus transmission: contributing factors and clinical implications 2010 Expert Reviews in Molecular Medicine p1

This study is available @ GreenCleanAir.com

How do people eject viruses into the air?

1. Coughing
2. Sneezing
3. Talking
4. Singing
5. Flatulence
6. Toileting “event” especially diarrhea
7. Toilet flush aerosolization (indirectly)

Studies using DNA testing show that airborne flu viruses are everywhere!

- As an Indoor Air Quality (IAQ) testing consultant, I can attest to the difficultly of trying to capture and isolate airborne germs. Harvard's Don Milton said it best: "Infectious aerosols are usually extremely dilute, and it is hard to collect and culture fine particles."[1]
- In 2006, CDC scientists perfected virus sampling equipment to collect and enumerate airborne viruses. They used layers of sieves to filter out particles, bacteria and fungi to finally end up with viruses.
- The next breakthrough was DNA/RNA testing called **Polymerase chain reaction (PCR).** Now viruses can be precisely measured.
- Studies have found thousands of airborne flu viruses by this method.
- Approx. 90 flu "copies" found by **PCR** testing equals 1 "viable" particle.

1. Milton, Don Roy, Chad Airborne Transmission of Communicable Infection- The Elusive Pathway New England Journal of Medicine April 2004 v350 p1710

More information on this study is available @ GreenCleanAir.com

CDC NIOSH study used viral replication assay showing coughs expel viable airborne flu viruses

"Viable Influenza A Virus in Airborne Particles from Human Coughs" 2014

CDC NIOSH's Dr. Stephen B. Martin and Drs. Noti, Lindsley, Beezhold and Blachere, et al.

Seventeen of these participants tested positive for influenza A virus by viral plaque assay (VPA) with confirmation by viral replication assay (VRA). **Viable influenza A virus** was detected in the cough aerosol particles from 7 of these 17 test subjects (41%). Viable influenza A virus was found in the smallest particle size fraction (0.3 μm to 8 μm), with a mean of **142 plaque-forming units** (SD 215) expelled during the 6 coughs in particles of this size. These results suggest that a significant proportion of patients with influenza A release small airborne particles containing viable virus into the environment. Although the amounts of influenza A detected in cough aerosol particles during our experiments were relatively low, larger quantities could be expelled by influenza patients during a pandemic when illnesses would be more severe.

Our findings support the idea that airborne infectious particles could play an important role in the spread of influenza.

How Airborne Droplet Nuclei are created

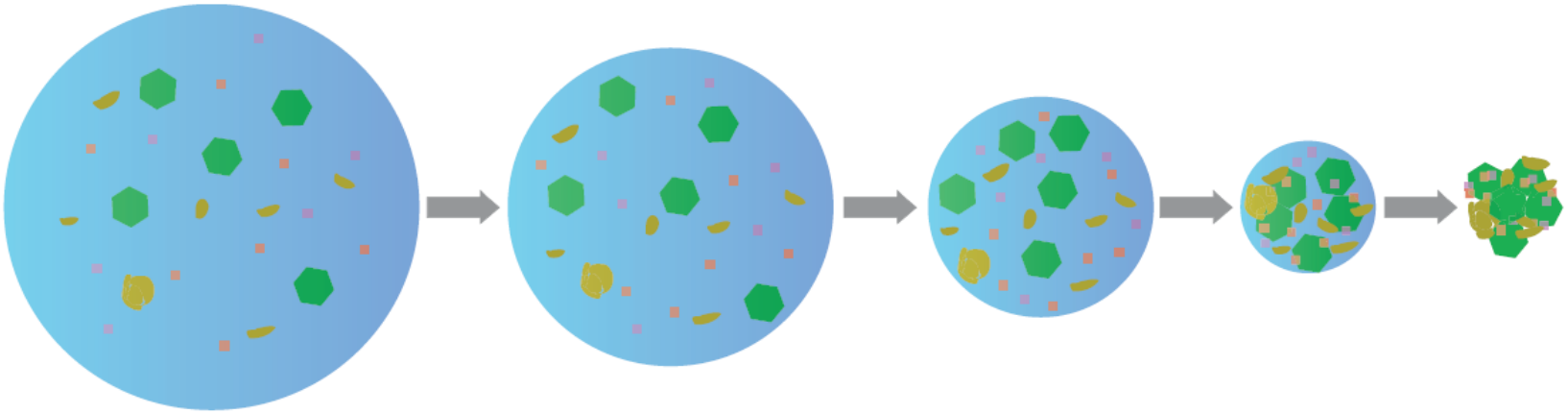


FIG. 2. Evaporation of a liquid droplet (left) to a droplet nucleus (right). As the liquid evaporates, the nonevaporative content concentrates until a droplet nucleus is obtained.

Airborne viral droplets are coughed, sneezed or expelled by humans. Toilet aerosolization also creates viral droplets.
This illustration shows how the mucus droplets filled with viruses eventually evaporate to create microscopic masses of viruses, salt and protein called Droplet Nuclei. Named and discovered by William F. Wells in 1934, droplet nuclei are the key to understanding airborne infectious disease transmission.

How many viruses do people eject into the air?

Table 5. *The calculated numbers of the respiratory droplets which are likely to contain pathogenic or commensal organisms*

The calculations were based on the figures given in Tables 3 and 4.

Expiratory activity	30,000,000 commensals per ml.	1,000,000 pathogens per ml.	30,000 pathogens per ml.	1000 pathogens per ml.
One sneeze:				
Under 100 μ	62,000	4,600	150	5
All sizes	73,000	14,000	3,100	430
One cough:				
Under 100 μ	710	64	2	0
All sizes	910	230	47	6
Counting to '100'				
Under 100 μ	36	3	0	0
All sizes	50	14	3	0

J.P Duguid The size and duration of air carriage of Respiratory Droplets and Droplet nuclei 1946 Journal of Hygiene (London) v44 p471

This study is available @ GreenCleanAir.com

Natural flu infection (airborne into lungs) is worse than intranasal (contact into nose)

(For nasal induced flu it takes 330 infectious flu viruses (TCID50) to get infected versus 1-3 infectious flu viruses for airborne infection in the lung.)

"To assess the relative effect of natural versus experimental (intranasal) influenza illness on pulmonary function, we compared 43 normal adults with documented non-pneumonic **influenza A infection** during three outbreaks, 1974 (A/Port Chalmers/74), 1975 (A/Port Chalmers/74), and 1976 (A/Victoria/75) to 24 **normal** volunteers following nasal inoculation with wild-type influenza A/England/42/72, A/Scotland/74 or A/Victoria/75."

In **naturally acquired illness**, abnormalities in **small airway function** and **transiently increase airway reactivity** were observed. In contrast, no such dysfunction was observed in experimentally induced illness. This group manifested milder illness and significantly shorter duration of cough."

Little, JW et al. Attenuated influenza produced by experimental intranasal inoculation. Journal of Medical Virology 1979;3(3):177-88.

How many viruses are floating in a room to infect you?

In 2011 Dr. Linsey Marr of VA Tech published: “Concentrations and size distributions of airborne influenza A viruses measured indoors at a health centre, a day-care centre and on aeroplanes”

“To determine the potential for influenza to spread via the **aerosol route**, we measured the size distribution of airborne influenza A viruses. Over 1 hour, the inhalation dose was estimated to be between **12 and 48** median tissue culture infectious dose (TCID50), adequate to induce infection. **These results provide quantitative support for the idea that the aerosol route could be an important mode of influenza transmission**.”

Since it takes only 1-3 airborne viruses to infect you, at 1 virus per naïve person, fully 48 new people could be infected! Keep in mind that these were adults who are less infectious than children who can become “super-emitters” and spew out up to 200 viable flu viruses in a short time.

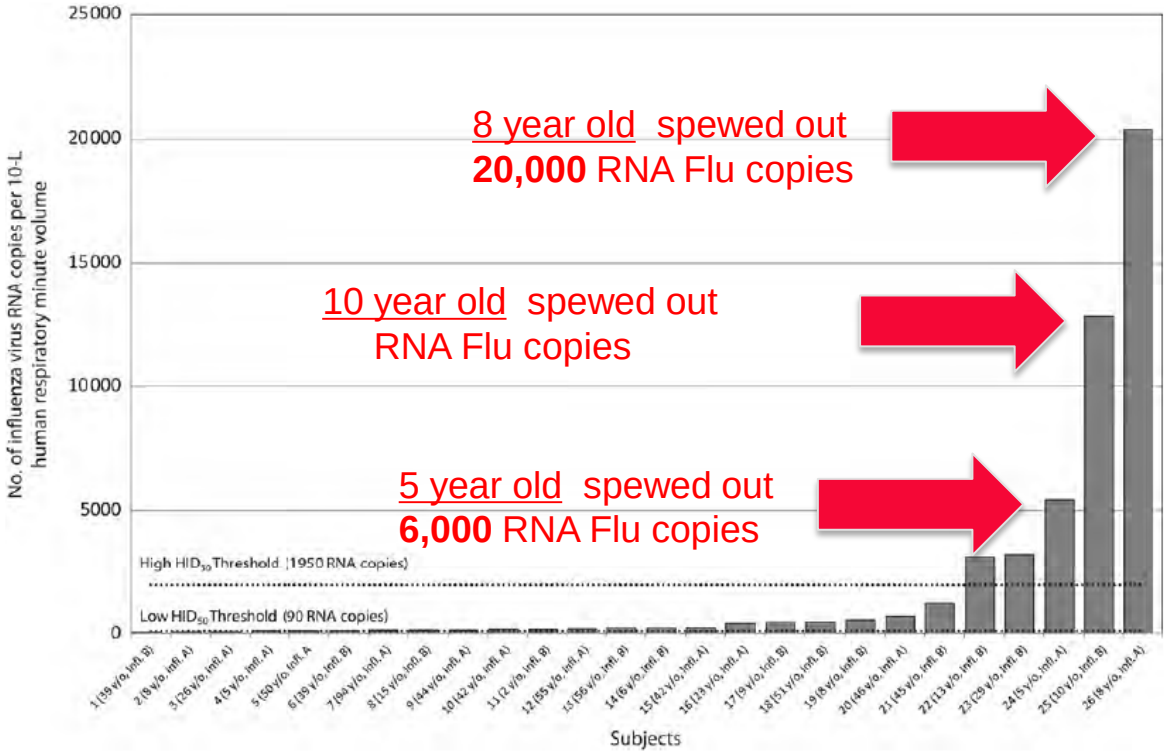
Linsey Marr et al. Concentrations and size distributions of airborne influenza A viruses measured indoors at a health centre, a day-care centre and on aeroplanes J. R. Soc. Interface 2011 v8 p1176

This study is available @ GreenCleanAir.com

Wake Forest Research discovers the "Super-Emitter" (New Typhoid Mary?)

Dr. Walter Bischoff discovered that flu infected persons at Wake Forest Hospital were spewing flu viruses in volume and distance. One 8yr old super-emitter spewed out **20,000** RNA copies= **200 infectious flu viruses.**

This child could infect 66 (3 viruses) to 200 (1 virus) naïve classmates within 1 hour!



Exposure to Influenza Virus Aerosols During Routine Patient Care
Walter Bischoff et al. Journal of Infectious Diseases Feb 2013

How does Influenza A Virus infect people?

1. Fingers to nose?
2. Fingers to eye?
3. Fingers to mouth?
4. Inhale Large droplets
5. Inhale Intermediate droplets
6. Inhale droplet nuclei
7. Toilet flush aerosolization
8. Sewer pipe aerosolization

What's Influenza A Virus and how does it infect people?

- Influenza A causes disease primarily in the lungs as it loves to infect the lower respiratory tract (LRT).
- It is not a rhinovirus which primarily causes infection in the nose and upper respiratory system.
- Since your fingers can't reach into your lungs, washing your hands can't prevent flu viruses from entering deep into your lungs.
- No matter how sterile your hands are, you'll still be fully exposed to airborne Influenza viruses entering and depositing into your lungs and lower respiratory tract to cause disease.

How does Influenza A Virus kill people?

- Influenza A likes to multiply at 98.6F which is the temperature of the lower respiratory system. (The upper respiratory system- nasal cavity & pharynx- are approx. 94F which rhinoviruses favor for multiplication).
- Influenza A infects and destroys its victim's lung tissue.
- Damaged lung tissue has compromised its protective layers which can lead to severe pneumonia or overwhelming bacterial infection.
- Victims can die from aggressive Staph infections like Methicillin Resistant Staphylococcus Aureus (MRSA).

Why are schools perfect petri dishes for Flu Transmission?

- **Super-emitters** Flu infected children can, with their immature immune systems, become "super-emitters" and Wake Forest's Dr. Walter Bischoff discovered[1] that an 8yr old super-emitter spewed out **20,000** RNA copies= **200 infectious flu viruses.**

- **Dry environments** Many schools can have 15-25% relative humidity levels indoors! This is the PERFECT environment for airborne Viral transmission and contagion.

- **Low MERV Filter Ratings** Many schools have low MERV rated filters like MERV 4-6. You need a MERV 13 or higher to have any real effect on airborne viral capture.

- **No Ultraviolet Lights** Few schools in the US use ultraviolet lights. Schools with UV lights have enjoyed lower airborne germ transmission rates and higher indoor air quality.

- **Bathrooms with ceiling exhaust fans** Most bathroom designs do not incorporate floor level exhaust vents. Ceiling exhaust fans pull toilet aerosolized viruses up into the breathing zone where they are breathed into the lungs of unsuspecting victims.

1. Exposure to Influenza Virus Aerosols During Routine Patient Care
Walter Bischoff et al. Journal of Infectious Diseases Feb 2013

2013 Mayo Clinic study shows how dry air in schools increases airborne Flu

A 2013 Mayo Clinic[1] study done over two years in Minnesota elementary schools showed just how low the humidity was inside when the outdoor air was dry and cold.

Schools are required to bring in outdoor air which, in a Minnesota winter, is very cold and dry. Most importantly this cold dry air had very little "grains" of moisture so when it is brought indoors, it dries out the indoor air to as little as 12% relative humidity. My 2010 article[2] on airborne flu survival puts 15%rh and 65ºF in the high flu transmission zone and illustrates how influenza viruses survive so well in low grain air.

The Mayo study showed that by humidifying the air to 60% relative humidity (from 15%) would reduce the Airborne Flu survival rate by over 50% in just one hour! So just by adding humidity, which is toxic to airborne flu viruses, you'd kill (inactivate) more than half of them. With less airborne viruses to breathe, the less chance that a child will become ill with flu.

The Mayo Clinic researchers conclude:"raising wintertime indoor AH to levels typically experienced indoors during fall and spring (60%rh) offers a strategy to reduce transmission of influenza in schools, and potentially the community."

1. Predictors of indoor absolute humidity and estimated effects on influenza virus survival in grade schools Koep et al. BMC Infectious Diseases 2013, v13 p1
2. Save Lives! Become a mechanical engineer. Steven Welty Engineered Systems January 2010 page 57

This open source study and article are available @ GreenCleanAir.com

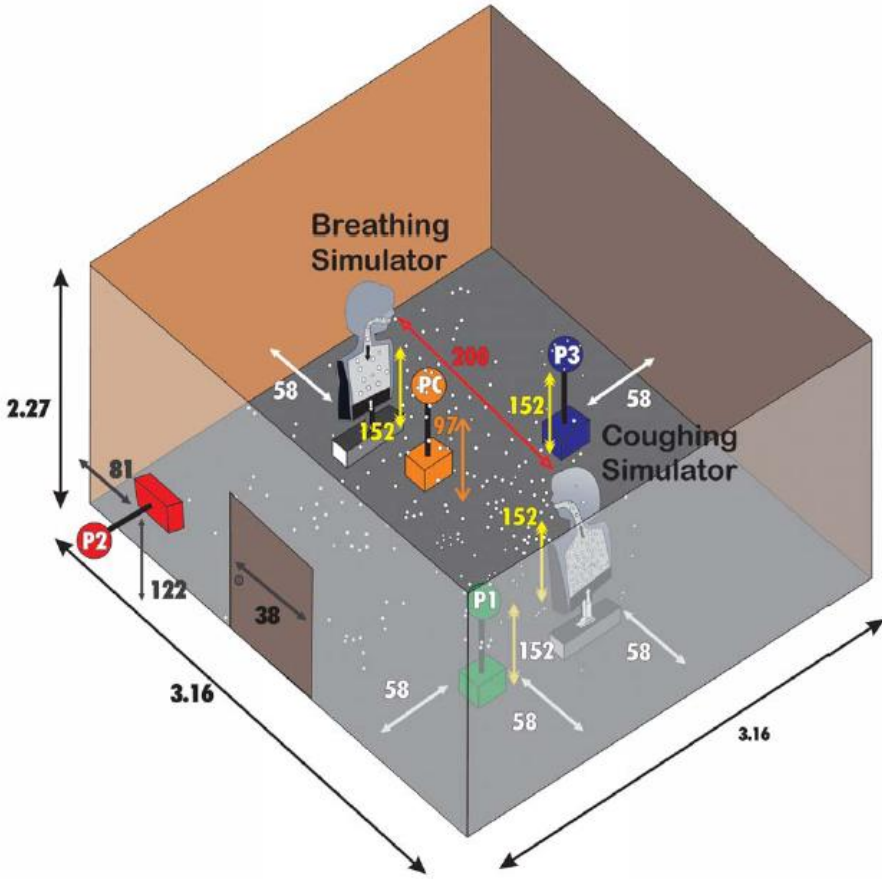
2013 CDC/NIOSH study shows how dry air increases airborne Flu survival, infectivity and transmission explaining "flu" season!

CDC/NIOSH researchers demonstrated[1] how low humidity air was the key factor in increasing airborne flu survival, infectivity and therefore successful transmission from a flu infected "simulated" (ie. manikin) to a healthy healthcare worker manikin (shown at right as Breathing Simulator).

CDC/NIOSH researchers conclude:

1. **At low relative humidity (≤23%) influenza retains maximal infectivity (70.6–77.3%)**
2. **At higher relative humidity (≥43%) influenza has much lower infectivity (14.6–22.2%)**
3. **Inactivation of the virus at higher relative humidity (≥43%) occurs rapidly after coughing (within 15 minutes.)**

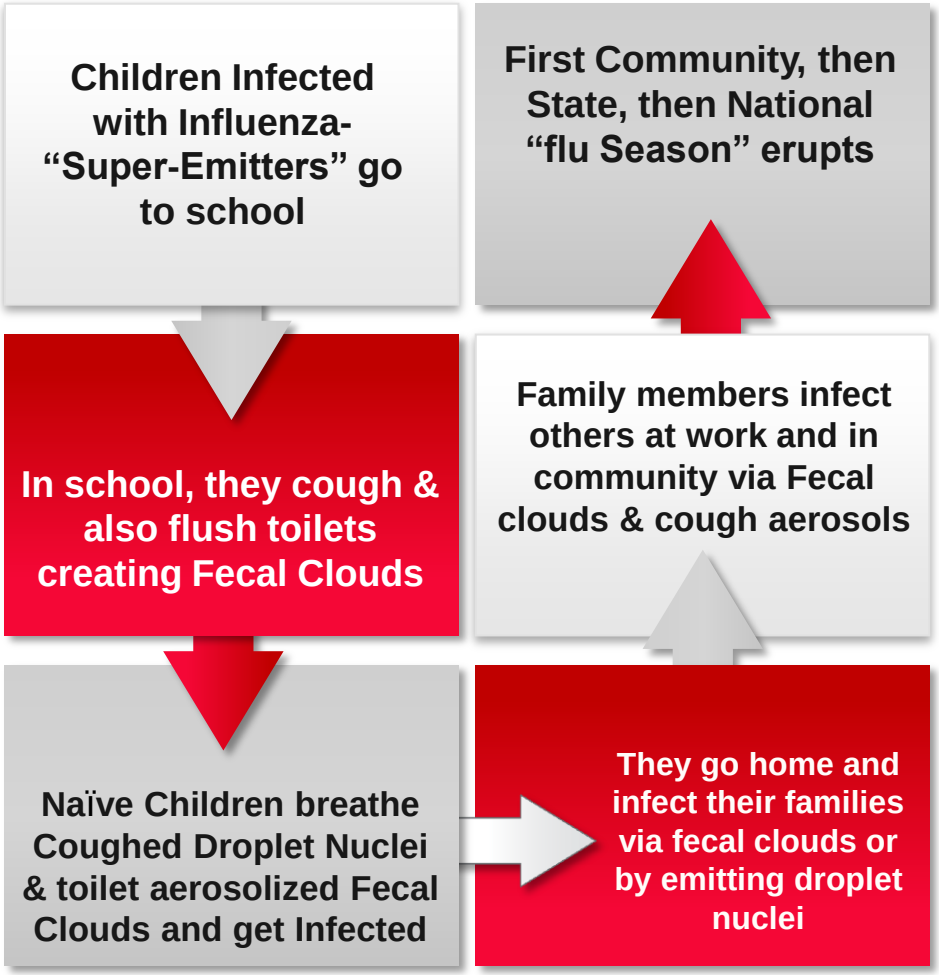
Their Recommendation: "Maintaining indoor relative humidity above 40% will significantly reduce the infectivity of aerosolized virus."



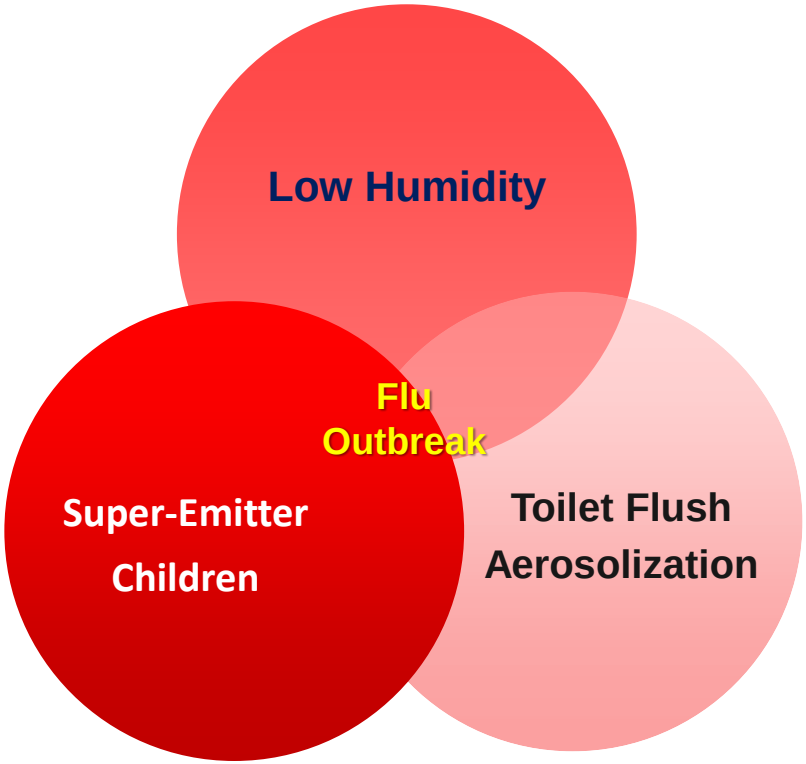
1. High Humidity Leads to Loss of Infectious Influenza Virus from Simulated Coughs Noti, John et al. PLoS 2013, v8 epage-57485

This open source study available @ GreenCleanAir.com

Children, Super-Emitters and National “Flu Season”



Why Schools are the Vector Source For Flu Season



1. In schools, the combination of low humidity, super-emitter children and toilet flush aerosolization is a toxic combination.
2. Low humidity ensures that airborne viruses will stay aloft and travel throughout the school.
3. Super-emitter children continuously add airborne viruses into the air through breathing, coughing and sneezing, and add even more with every toilet flush.

Leading virologists Peter Wright, Gabrielle Neumann and Yoshihiro Kawaoka state that flu epidemics start in schools

Virologists Peter Wright[1], Gabrielle Neumann[2] and Yoshihiro Kawaoka[3] state: "Increases in school absenteeism mark the beginning of a new epidemic, suggesting that school-age children play a critical role in disseminating influenza viruses. Increases in school absenteeism are typically followed by increases in work absenteeism."[4]

These experts support my thesis that Schools are the "petri dish" for flu. Since flu infected children can, with their immature immune systems, become "super-emitters", they easily infect their classmates as they all intermingle while traveling from classroom to bathroom to gym to lunchroom all the while super-emitters are spewing out infectious flu viruses.

Parents and the companies they work for have many good reasons to take a vested interest in advocating for clean and properly humidified air in schools especially in the dry wintertime.

1. Professor Pediatrics, Pathology, Microbiology and Immunology Chief, Division of Pediatric Infectious Diseases Vanderbilt University School of Medicine
2. Associate Professor Department of Pathobiological Sciences School of Veterinary Medicine University of Wisconsin
3. Professor Department of Microbiology and Immunology University of Tokyo
4. Fields Virology 2007 Fifth Edition Page 1705

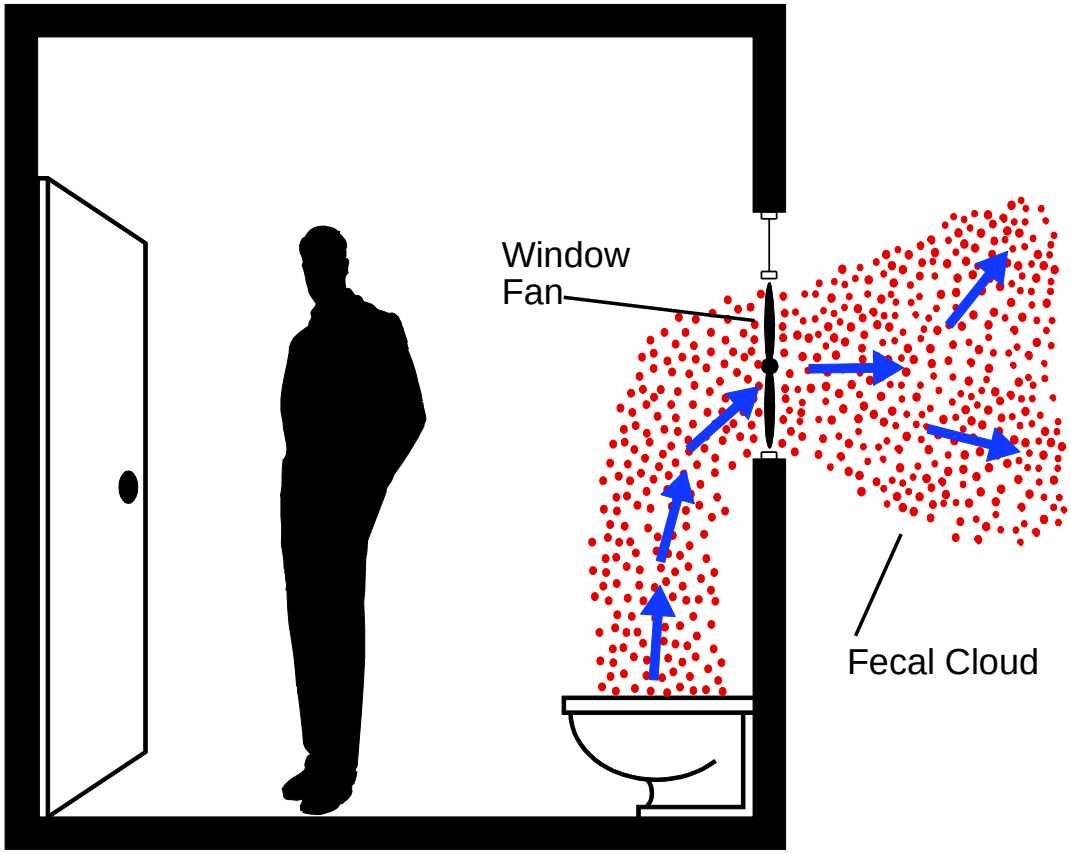
How far can Airborne Viruses Travel?

	Large Droplets/Aerosols	Droplet Nuclei
1. Coughing	1-6 feet	200+ feet
2. Sneezing	8-15 feet	200+ feet
3. Singing, Talking	1-3 feet	200+ feet
4. Mouth Breathing	1-3 feet	200+ feet
5. Diarrhea*	1-5 feet+	**600+ feet**

*As a Result of Toilet Water Aerosolization and Mechanical Fan Dispersion into outdoor air (2003 Hong Kong Amoy Gardens SARS Virus Epidemic)

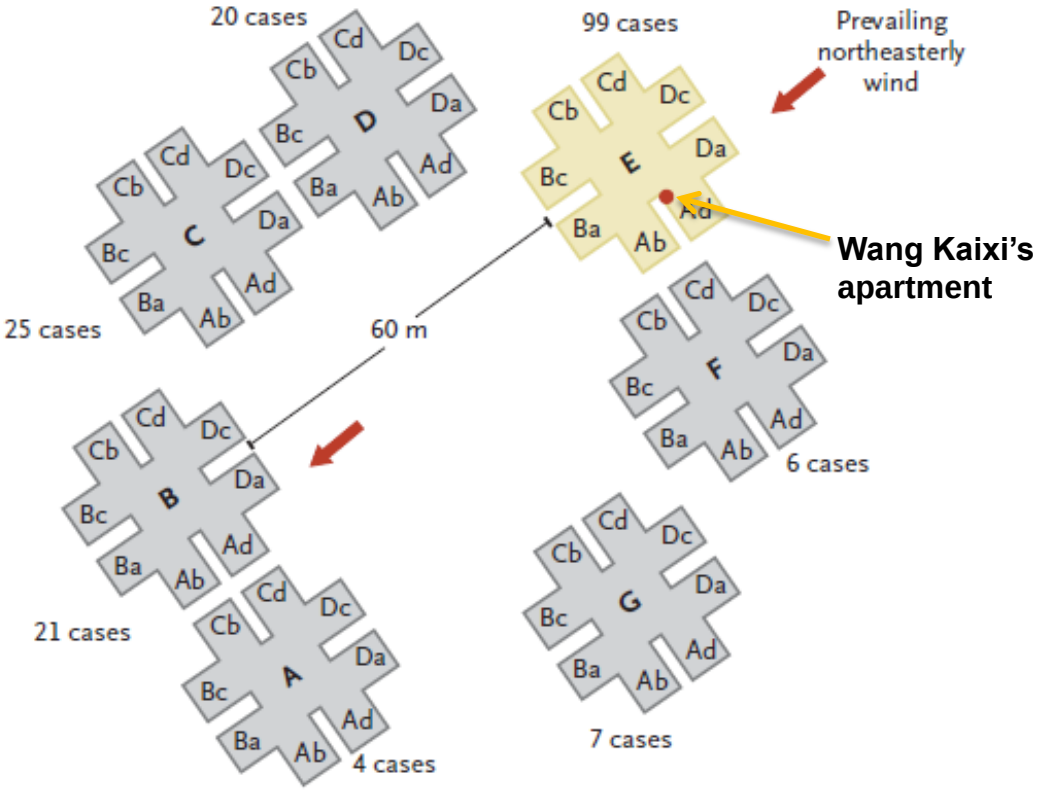
Airborne SARS Transmission at Amoy Gardens Apartments 03.19-20.2003

Wang Kaixi was infected by airborne SARS viruses that he breathed in at the Prince of Wales Hospital.
Since SARS produced diarrhea in the majority of patients, he flushed his toilet water likely heavily laced with his SARS thereby aerosolizing his SARS viruses into the most toxic Fecal Cloud ever recorded.
His window fan blew his SARS Fecal Cloud(s) outdoors where the wind and rising air currents spread them on to his unsuspecting Amoy Gardens neighbors.



The largest airborne infection event ever recorded-Amoy Gardens March 19-20, 2003

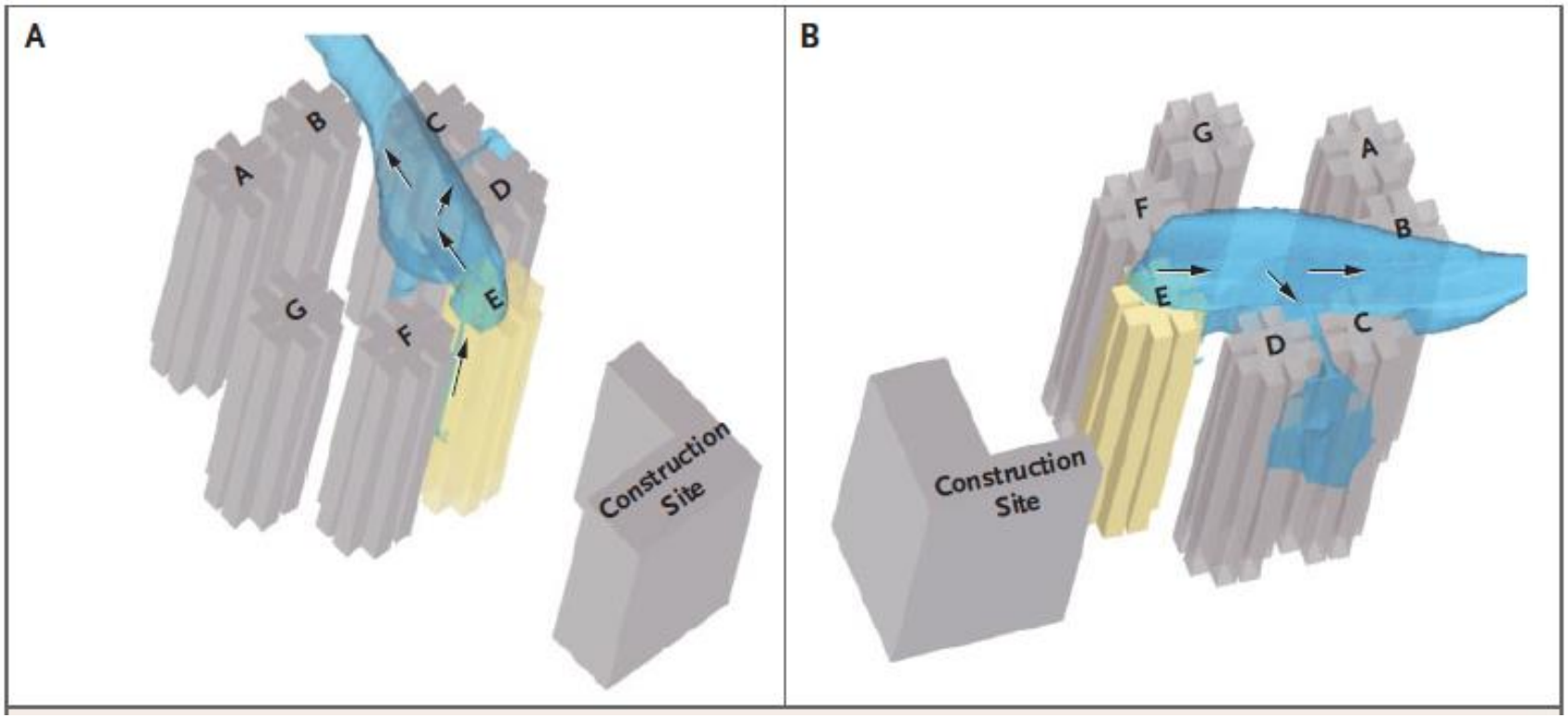
Retrospectively, Professor Yuguo Li documented the airborne toilet aerosolization SARS Plume created by Wang Kaixi. The plume traveled mostly upwards and infected nearly 100 neighbors in his building (Block E). It then traveled over 200 feet (70 meters) to infect more Amoy residents. Over 40 died.



Li, Yuguo et. al Evidence of Airborne Transmission of the Severe Acute Respiratory Syndrome Virus 2003 NEJM

This study is available @ GreenCleanAir.com

Wang Kaixi infected 440 people downwind- 40+ were killed @ Amoy Gardens by 1 person!



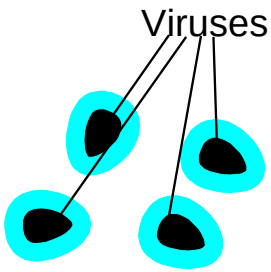
Wang Kaixi's SARS toilet flush fecal cloud visually demonstrated both the ability & power of airborne viruses to travel long distances to infect and kill new healthy naïve victims.

Li, Yuguo et. al Evidence of Airborne Trans-mission of the Severe Acute Respiratory Syndrome Virus 2003 NEJM

This study is available @ GreenCleanAir.com

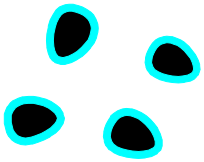
Stages of Infectious Droplets & Droplet Nuclei

Large droplets-20µ+



1. Mucus/water coated Viruses are aerosolized and they can't evaporate fast enough and quickly fall to the ground.

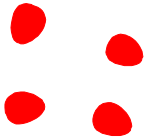
Small droplets/aerosols-10-20µ



2. Mucus/water coating evaporates. These droplets will travel 3-6 feet before falling to the ground.

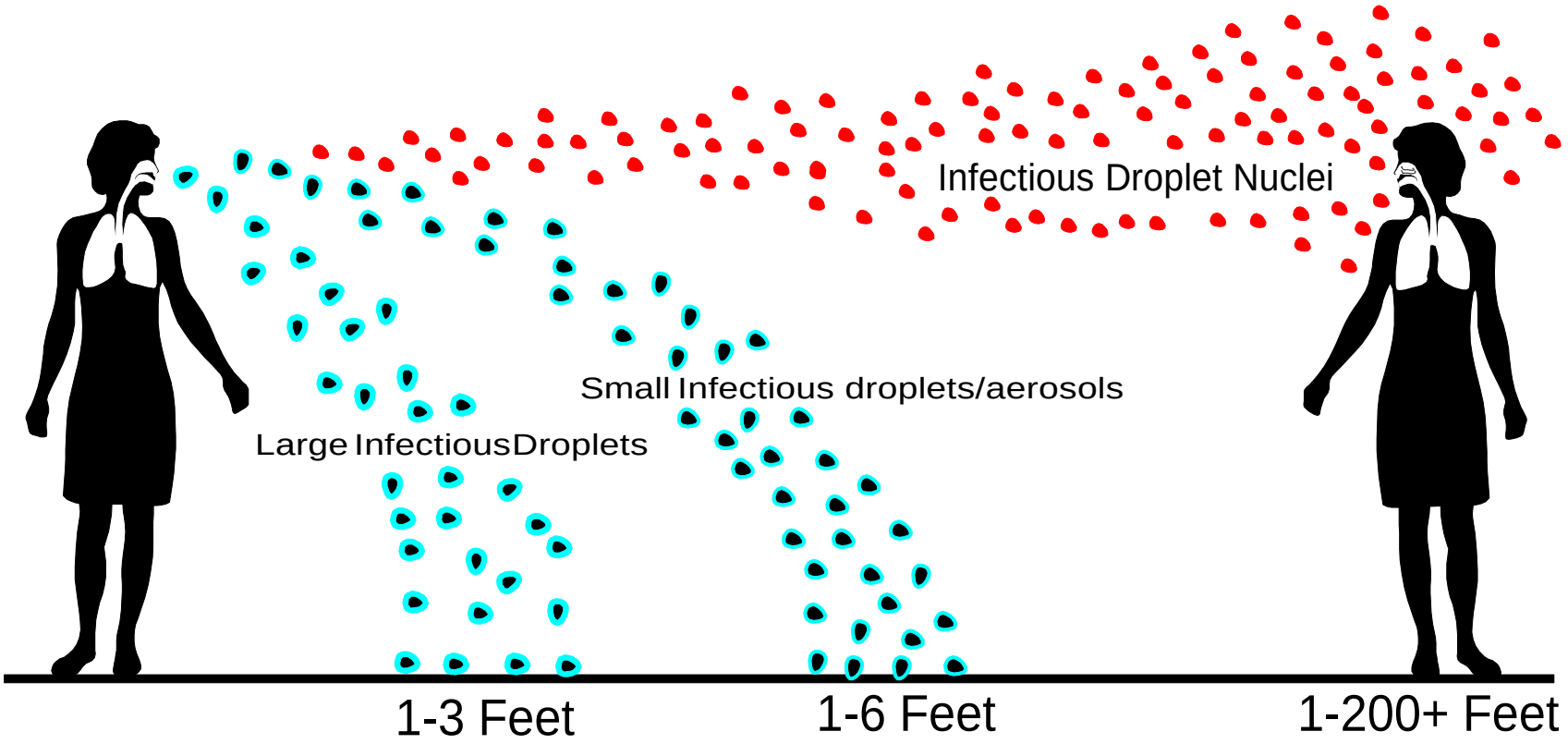
µ = micron or 1 millionth of a meter

Droplet Nuclei- <10µ

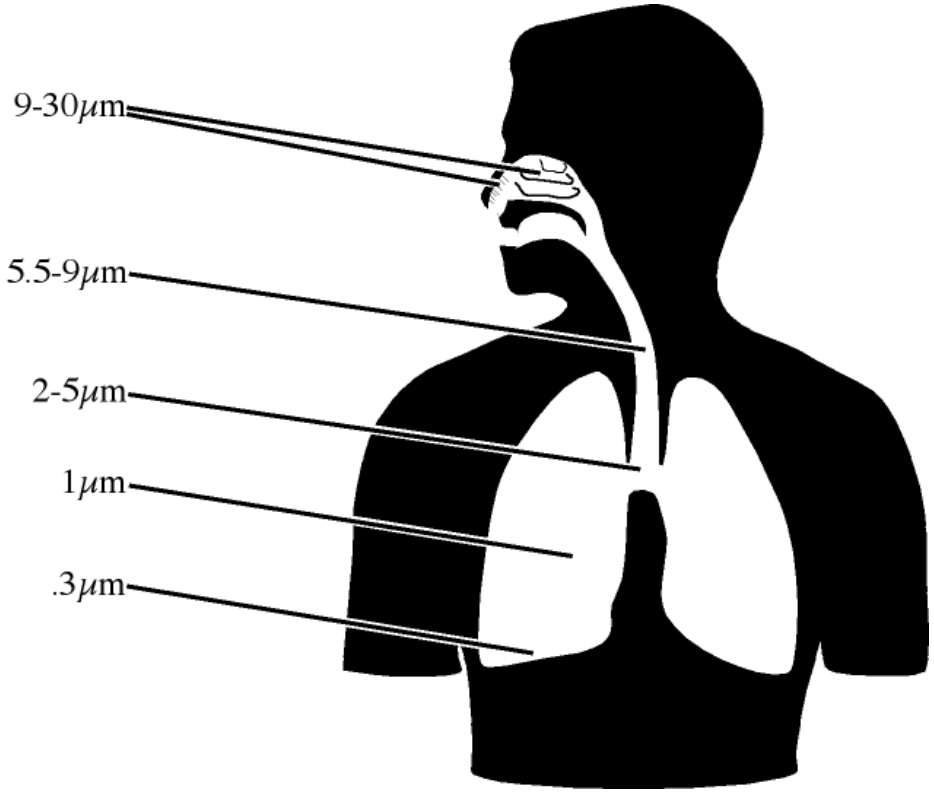


3. Mucus/water coating has mostly evaporated leaving the virus with protein & salts. This is a Droplet Nuclei . Droplet Nuclei are so microscopic that they can float in the air indefinitely.

Infectious Droplets & Droplet Nuclei travel lengths

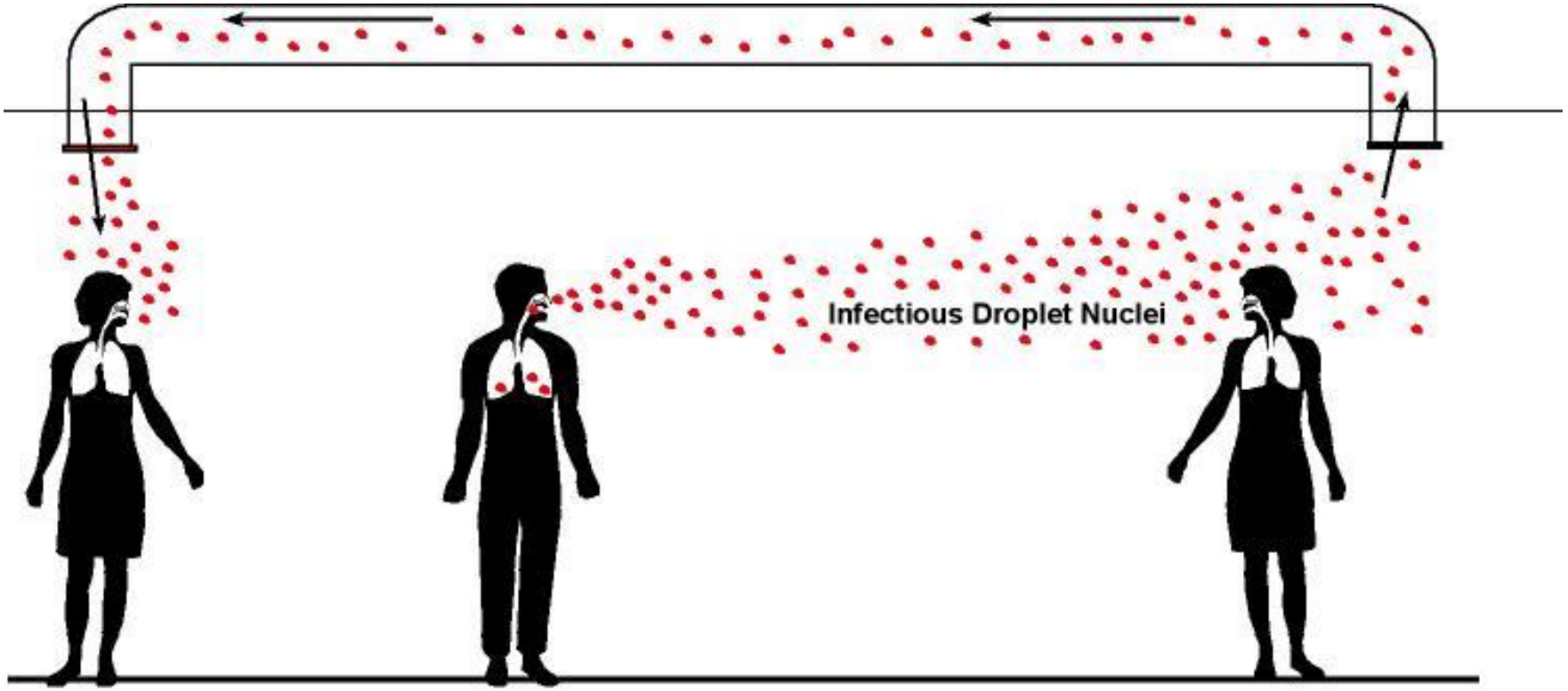


Droplet Nuclei Viruses are .3µ or Less & Penetrate Deeply into the Human Lungs

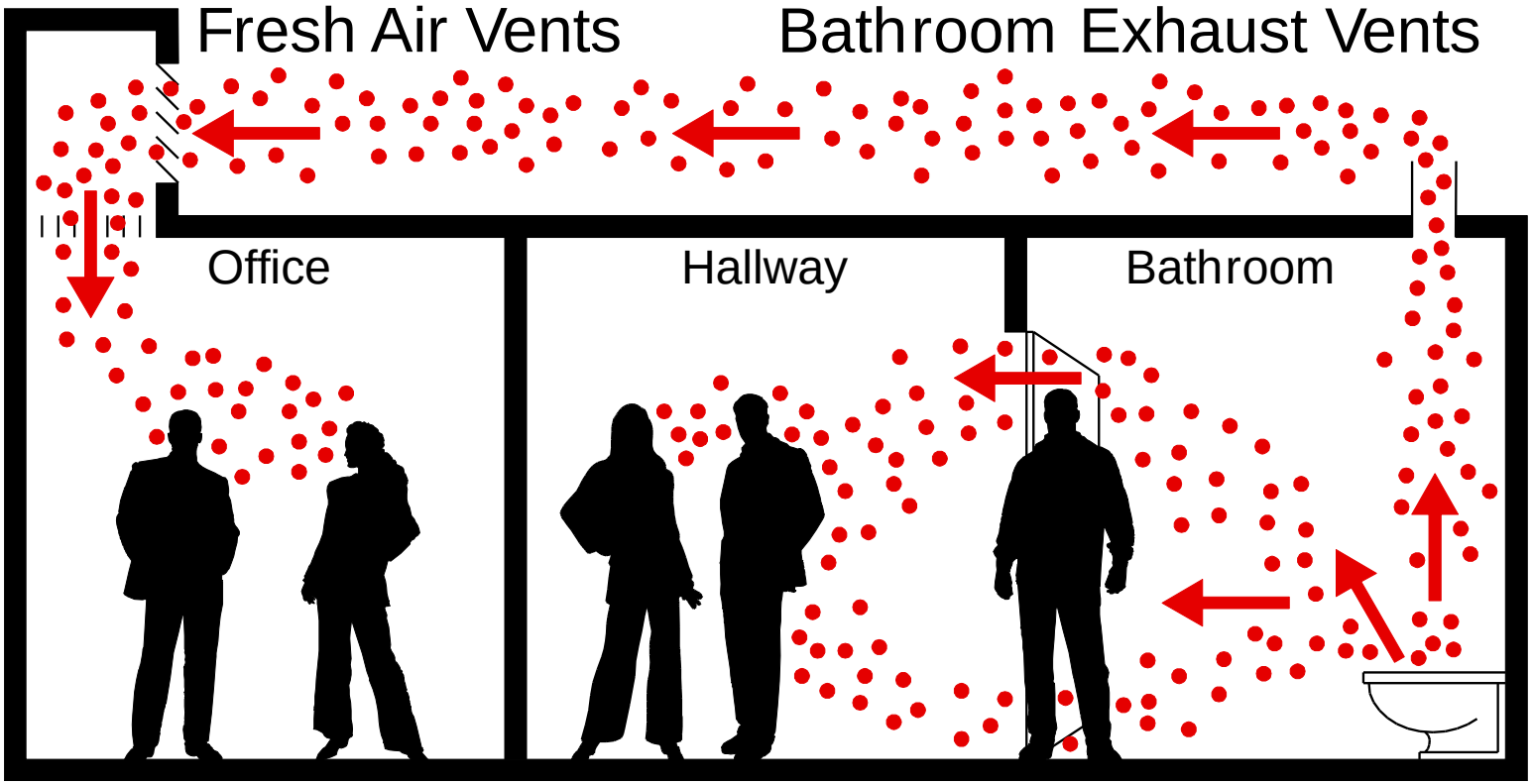


A µm is a micron or 1/1,000,000 of a meter.
The smallest particle you can see is 30µm.

Droplet Nuclei Travel Within Buildings



How Toilets Aerosolize Flu Viruses
Recirculation Vents suck them back in



Toilet Water Viral Aerosolization

- **Since 1955, many studies have documented how a toilet flush aerosolizes bacteria and viruses into the air above the bowl and into the room's air.**
- **Many scientists flushed toilet bowl water infected with a known quantity of viruses and measured just how far they stayed airborne.**
- **British Scientist John Barker[1] in 2005, (post 2003 SARS Metropole & Amoy Garden events) replicated the viral load and consistency of diarrhea using agar. He added that to toilet water, flushed the toilet and took air samples to capture the aerosolized droplets. They were full thousands of viruses and bacteria. For 60 minutes afterwards, every toilet flush aerosolized additional viruses because porcelain is porous enough to harbor viruses and bacteria also.**

1. Barker, John The potential spread of infection caused by aerosol contamination of surfaces after flushing a domestic toilet. 2005 Journal of Applied Microbiology v99 p339

This study is available @ GreenCleanAir.com

Toilet Water Aerosolization Studies Reviewed by Dr. David Johnson for the CDC/NIOSH

"It may be concluded from the peer-reviewed studies discussed above that flush toilets of various designs spanning at least 50 years of production in Europe and the U.S. have been shown to produce **substantial quantities of aerosol**, that these aerosols are capable of **entraining microorganisms** at least as large as **bacteria** (*includes **viruses** which are 10 timer smaller**), that such bioaerosols will be produced during multiple flushes after toilet contamination, that sufficiently small microbe-laden droplets will evaporate to form **droplet nuclei bioaerosols** the size of which can be consistent with that associated with **respirable penetration**, and that these droplet nuclei bioaerosols may remain **viable in the air for extended periods and travel with air currents.**"[1]

*** Added by Steven Welty**

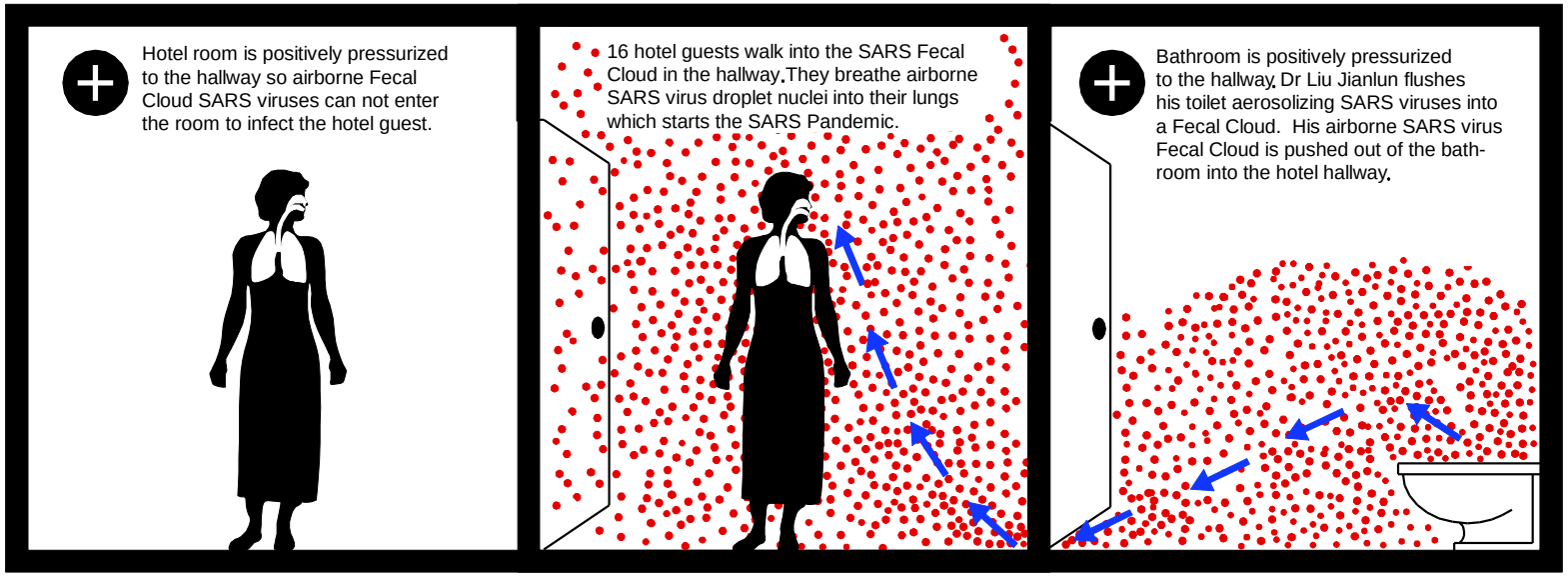
1. Toilet Plume Aerosol Occupational Hazards to Healthcare Facility Workers: A Review of the Literature with Suggestions for Future Research David L. Johnson, PhD, PE, CIH 2011. The CDC funded this research so it is available @Greencleanair.com Dr. Johnson, Dr. Ken Mead et al. edited, peer reviewed and published online paper in the American Journal of Infectious Diseases, March 2013 is titled: "Lifting the lid on toilet plume aerosol: A literature review with suggestions for future research".

Toilet Water Viral Aerosolization in Hong Kong

The 2003 SARS epidemic showcased the lethality of toilet water aerosolization which created Fecal Clouds in these published accounts:

1. **Dr. Liu Jianlun was the Chinese Doctor who initiated the worldwide SARS pandemic. He stayed one night in Hong Kong on the 9th floor (room 911) at the Metropole Hotel on the evening of February 21st to the morning of the 22nd in 2003.**
   - **Infected with SARS and likely having diarrhea, he infected 16 fellow hotel guests and 1 visitor through toilet water aerosolization. Some of those travelers flew around the world and one brought SARS to Toronto thereby devastating the city.**
2. **Wang Kaixi was infected with SARS at the same hospital which was treating a SARS infected patient who visited a hotel guest's whose room was on the same hall as Liu Jianlun at the Metropole hotel.**
   - **Infected with SARS and likely having diarrhea, he eventually infected over 320 Amoy Garden residents through toilet water aerosolization. Many lived over 200 feet away from his apartment. He killed over 40.**

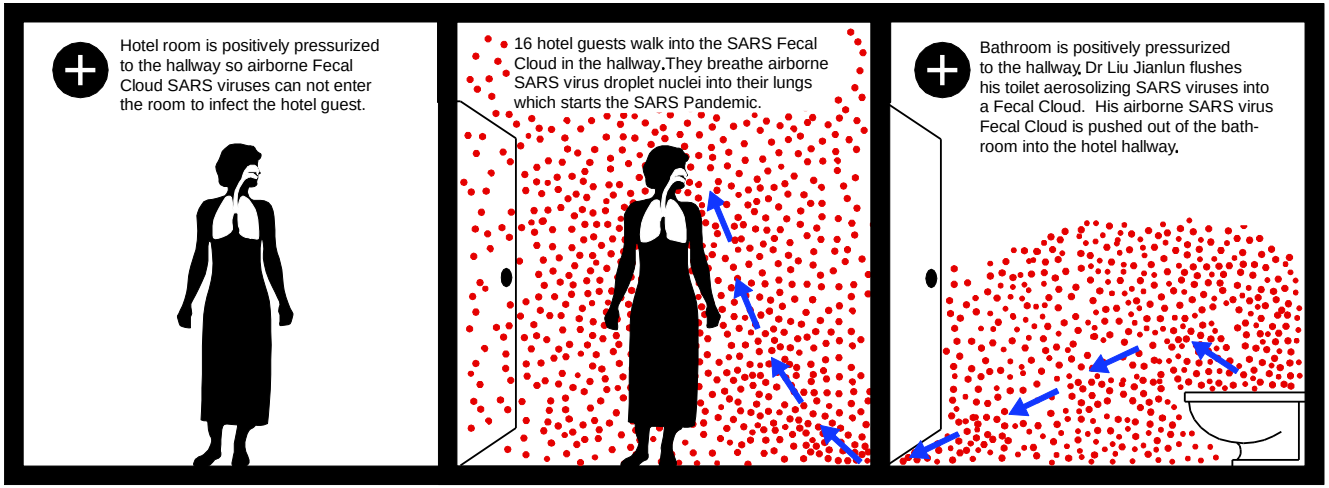
Airborne SARS Transmission at The Metropole Hotel 02.21-22 2003



The above scenario contradicts the current belief that Dr. Jianlun spread his SARS viruses to his fellow Hotel guests by vomiting on the carpet outside his room. The currently accepted vomit theory may be due to the World Health Organization's investigators speculating that Dr. Liu Jianlin may have vomited on the carpet outside his room. "It was speculated that he might have vomited, spit or heavily coughed near his room and, thus, contaminated this area of the corridor. In case of a vomit, the hotel staff might have been called for clean up. However, there is no record of such an incident.[1]" Most importantly, Thomas Tang, who was the epidemiologist with The Hong Kong Health authority, contacted Mrs. Jianlun who said her husband Liu never vomited.[2]

1. **Page 8 The WHO Metropole Hotel Report 2003 - available @ GreenCleanAir.com**
2. **Page 62 Twenty First Century Plague-The Story of SARS Thomas Abraham 2004**

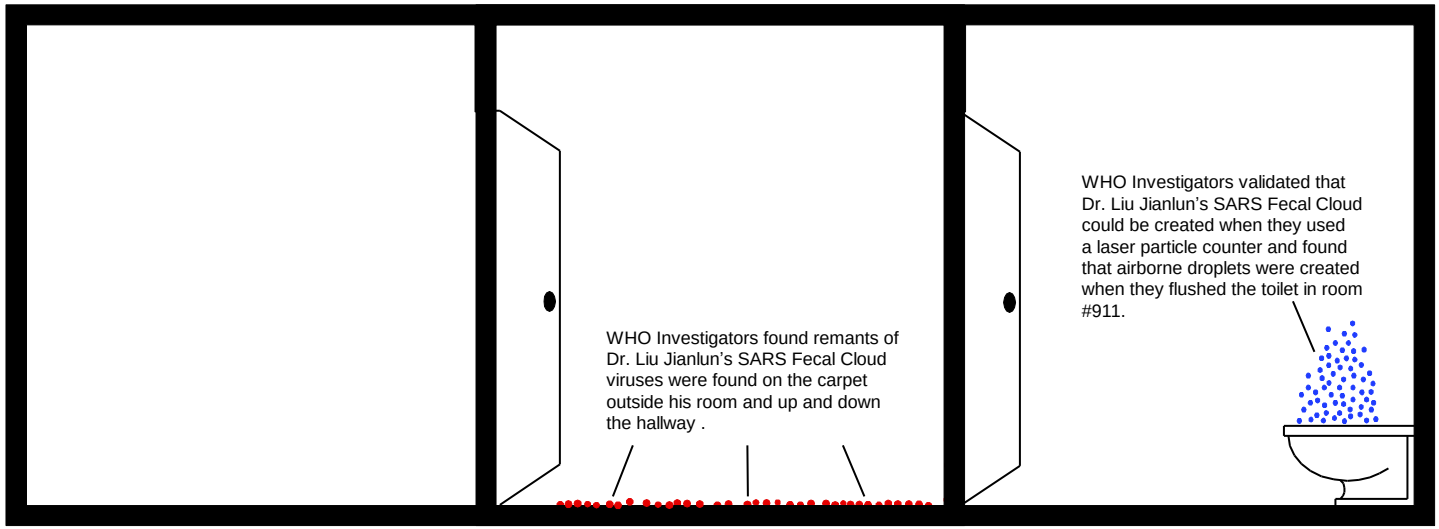
The WHO Investigation Report Metropole Hotel 02.21-22 2003



WHO investigators validated major parts of the above scenario confirming that Metropole guest rooms: "proved to be at positive pressure with respect to the corridor….(so) contaminated air could leave a room and transfer into the corridor with all doors closed."[1] Guest rooms had wall air conditioning units (fan coil) which brought in outdoor air. When operating, the fan coil units created this situation: "The positive pressure slightly increased when the operating status of the fan coil was changed from stopped to low, medium and high fan speed. As expected, the higher fan speed produced higher room pressure and thereby higher room airflow from below the door" [2] (and out into the hallway corridor to wreak havoc).

1. Page 8, 2. Page 5, in: Final Report Metropole Hotel WHO 2003 available @ GreenCleanAir.com

The WHO investigation Test Results- Metropole Hotel 4.27.2003



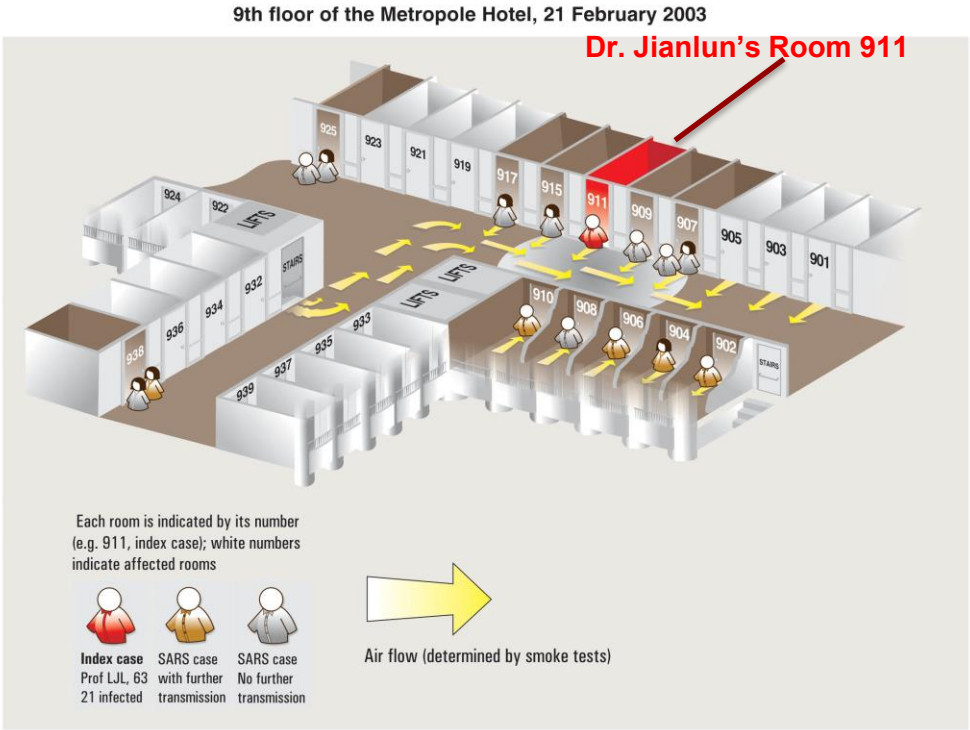
The 2003 WHO investigators confirmed the Fecal Cloud creation scenario using a laser particle counter: "Particle counting was done at the rim of the WC and again approx. 300 mm (12 inches) above the WC during flushing. The tank flush produced approximately 0.2 mg/m^3 in air."[1] These airborne droplet readings are the material evidence of Dr. Jianlun's Fecal Cloud creation albeit post-facto the event. The 2006 WHO report[2] adds this validation: "Professor LJL's infected body fluids must have been aerosolized, as indicated by the traces on the inlet of the elevator lobby fan. See Barker[3] for airborne virus creation with diarrhea laced toilet water.

1. Page 11 Final Report Metropole Hotel WHO 2003
2. Page 147 How SARS was stopped WHO 2006
3. 2005. The potential spread of infection caused by aerosol contamination of surfaces after flushing a domestic toilet. Barker, John Journal of Applied Microbiology v99 p339

All available @ GreenCleanAir.com

2006 World Health Organization SARS report-Metropole Hotel Chapter 14

This illustration from a 2006 WHO report[1] shows how the airflows were moving on April 27th, 2 months post-facto but this needs clarification using the WHO's 2003 Final report. The air flowing out of the rooms is correct. But, "Corridor air also drifted towards the elevators. Corridor air movement in the vicinity of the rooms under study is very slow, with a drift towards the elevator lobby where an air extraction takes place… aerosols would slowly travel towards the elevator lobby".[2] In addition, the report notes: "The air movement is so slow that a person walking into the corridor can cause a reversal of airflow".[2]



1. SARS: How a global epidemic was stopped 2006 WHO
2. Final Report Metropole Hotel WHO 2003

Both are available @ GreenCleanAir.com

2003 World Health Organization Metropole Hotel Report

This illustration from a 2003 WHO report[1] shows how the airflows were moving on April 27th. See how the air was flowing out of Dr. Jianlun's door at 170 feet per minute!

As per the previous slide, the airflow was moving both ways up and down the hallway so the yellow arrows illustrate only half the story.

You can visualize just how the Fecal Cloud(s) moved up and down the corridors of the 9th floor. They were probably created in the evening of the 21st and likely existed into the morning of the 22nd. The clouds may have existed in an ever weakening state even after Dr. Jianlun walked 500 yards to Kwong Wah hospital that morning.

Each person walking through the Fecal Cloud, unaware of its presence, sucked in its toxic viruses and went on to spread them worldwide.

Figure 3. Schematic drawing of floor 9 of the Metropole Hotel. Each room is indicated by its number (e.g., 911, index case); red numbers indicate affected rooms. The air flow in this part of the floor was determined by smoke tests and is indicated by the yellow arrows. The numbers next to the arrows indicate the air velocity.

Dr. Liu Jianlun's Room 911

1. **Final Report Metropole Hotel WHO 2003** **available @ GreenCleanAir.com**

The World Health Organization Metropole Hotel SARS investigation report

The WHO investigators found SARS viruses on the carpet area outside Dr. Jianlun's room and the two rooms on either side of him on April 27, 2003 (2 months later). Since the SARS debris field is at least 30 feet long, the vomit theory becomes less tenable. It's more logical that the WHO investigators found the settled droplet nuclei SARS viruses of Dr. Jianlun's Fecal Cloud on the carpet. In addition, they found SARS viruses on the air vent opening on the wall near the elevators probably 6 feet above the floor and over 15 feet from room 911.

That SARS viruses were found in spite of massive cleaning efforts to "sanitize" the Metropole's 9th floor: "It is interesting to note that genetic material (SARS) could be detected after almost two months and following an extensive decontamination and clean up in the hotel, particularly floor 9 and the associated guest rooms." [1]

Figure 2: Schematic drawing of floor 9 of the Metropole Hotel. Each room is indicated by its number (e.g., 911, index case). The numbers of samples that resulted in a positive laboratory result are presented with the total number of samples taken from a particular location (e.g., 4/31).

4 SARS viruses found outside Dr. Jianlun's Room 911

4 more SARS viruses found on air vents 6 feet high on wall

1. Page 5, Final Report Metropole Hotel WHO 2003 available @ GreenCleanAir.com

Hospital Toilet Droplet Nuclei Infection Prevention

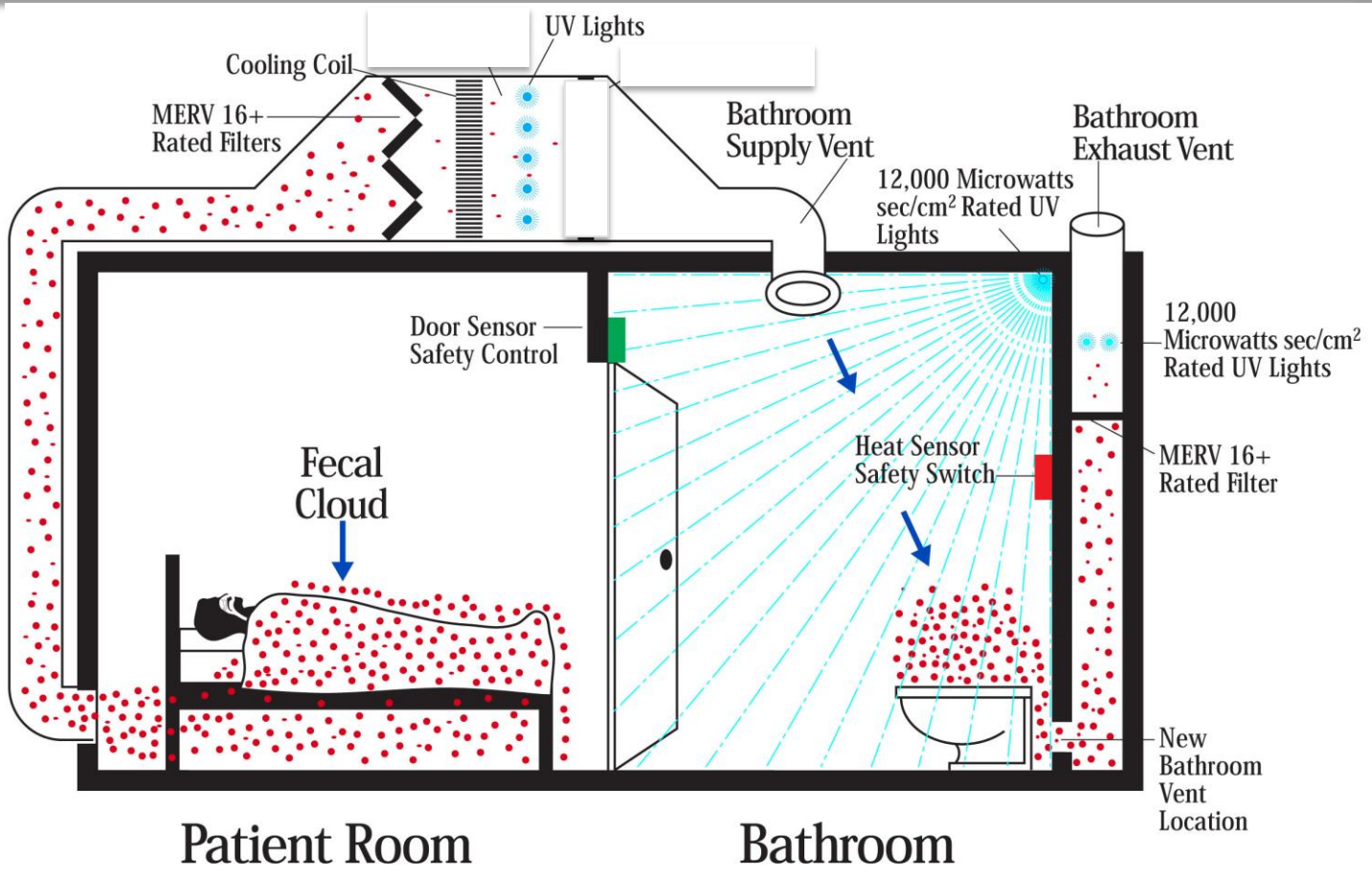


Illustration by Steven A Welty from article in Engineered Systems August 2011 – See GreenCleanAir.com

What conditions increase airborne flu virus survival, which increases infection probability?

1. Not being removed from indoor air by exhaust fans to outdoor air
2. Indoor Relative humidity below 40% at 70º (20% even better)
3. Not Captured by Gasket Sealed Nano-Rated HEPA Filters
4. No Exposure to Ultraviolet Light- “C” band, “germicidal” photons

Does Humidity matters to airborne flu viruses? Yes.

In 2011 Dr. Linsey Marr of VA Tech also published: “Dynamics of Airborne Influenza A Viruses Indoors and Dependence on Humidity”

“Humidity is an important variable in aerosol transmission of Influenza A Viruses because it both induces droplet size transformation[1] and affects Influenza A Viruses inactivation rates[2]……aerosol transmission route plays a significant role in the spread of influenza in temperate regions and that the efficiency of this route depends on humidity.”

Her recommendation: “Maintaining a **high indoor Relative Humidity** and ventilation rate may help **reduce chances of Influenza A Viruses infection.**”

1. Since mucus is mostly water and surrounds the virus(es), low humidities evaporate mucus faster making the virus aerosol lighter and easier for human to breathe down into their lungs. Droplet nuclei are the easiest to inhale deeply.
2. Since viruses aren’t alive, you technically can’t “kill them, you “inactivate” them making them non-viable/noninfectious.

Concentrations and size distributions of airborne influenza A viruses measured indoors at a health centre, a day-care centre and on aeroplanes J. R. Soc. Interface 2011 v8 p1176

This open source study is available @ GreenCleanAir.com

VA Tech's Dr. Linsey Marr discovered why flu viruses *love* low humidity!

In 2012 Dr. Linsey Marr of VA Tech published her experiments spraying human mucus with flu into the air with different humidities. She discovered that mucus's protein protects flu viruses from mucus salts in 50%rh or less air!

"Our findings in human mucus could help explain, at least in part, the transmission patterns of influenza. In temperate regions, wintertime heating reduces RH in the indoor environment to low levels, usually 40% (or less*)."

"Low RHs not only help preserve the viability[1] of Influenza A Virus but also enable Influenza A Virus carrier[2] aerosols to persist longer in air because of their smaller size and lower settling velocities[3] that result from more vigorous evaporation. Thus, transmission of influenza in temperate regions could be enhanced in winter primarily via the aerosol route."

1. Viruses are not "alive", so viable means being able to infect someone. Viruses hijack your own cells, tricking them into making more copies of viruses which explode out of the cell to infect more cells and repeat the process.
2. A carrier is a person who may be sick and experiencing flu symptoms. Asymptomatic carriers have no symptoms but can infect people via aerosols or toilet aerosolization.
3. Settling velocities is how fast aerosols fall to the ground. Microscopic droplet nuclei aerosols are so light that they have a negligible settling velocity meaning that they can stay airborne for days or more!

*Added by Steven A Welty

Linsey Marr, et al. Relationship between Humidity and Influenza A Viability in Droplets and Implications for Influenza's Seasonality 2012 PLOS Journal v7, e-page 46789

This open source study is available @ GreenCleanAir.com

Dr. G.J.Harper-1963 Experiment showed Influenza Survived in low humidity

The Influence of Environment on the Survival of Airborne Virus Particles in the Laboratory

By

G. J. Harper*

"These results do show that relative humidity, temperature..are of great importance in determining the ability of viruses to survive in air long enough ... for transmission to the respiratory tracts of susceptible hosts"

Table 2. % Viability at 6 hours

		Influenza		
	RH =	20 %	50 %	80 %
50°F	10°	63	42	35
71°F	22°	66	4	5

Harper, GJ The influence of environment on the survival of airborne virus particles in the laboratory.
Arch Gesamte Virusforsch. 1963 v13 p64

Dr. G.J.Harper-Experiments on Low Humidity's effect on Influenza Survival

Airborne micro-organisms: survival tests with four viruses

By G. J. HARPER

Microbiological Research Establishment, Porton Down, Salisbury, Wilts

Table 1. *Viability of airborne virus 0–23 hr. after spraying*

Temp. (°C.)		R.H. (%)	No. of tests	Percentage viable at given times (hr.) 0*	½	1	1½	4	6	23
				(*b*) Influenza						
7·0–8·0	43-46º	23–25	3	88	87	80	78	68	63	61
		51	3	66	49	75	61	39	42	19
20·5–24·0	69-75º	20–22	5	75	77	65	64	74	66	22
		34–36	3	86	93	58	59	66	53	14
		50–51	3	84	62	49	29	6·4	4·2	Trace
		64–65	3	77	45	29	15	6·6	3·2	N.D.
		81	4	67	55	22	13	6·4	5·0	Nil

Dr. G.J.Harper-Low Humidity's effect on Airborne Influenza Survival

Viable decay of influenza (Fig. 3)

Influenza virus showed a uniformly high viable decay rate at relative humidities above 50%. (Values at 50%, 65%, and 80% were so similar they are represented here by a single line.) After 4 hours, viabilities were around 6%. At lower relative humidities, 20% and 35%, viable decay was slow, 14—22% viability being found in clouds 23 hours old.

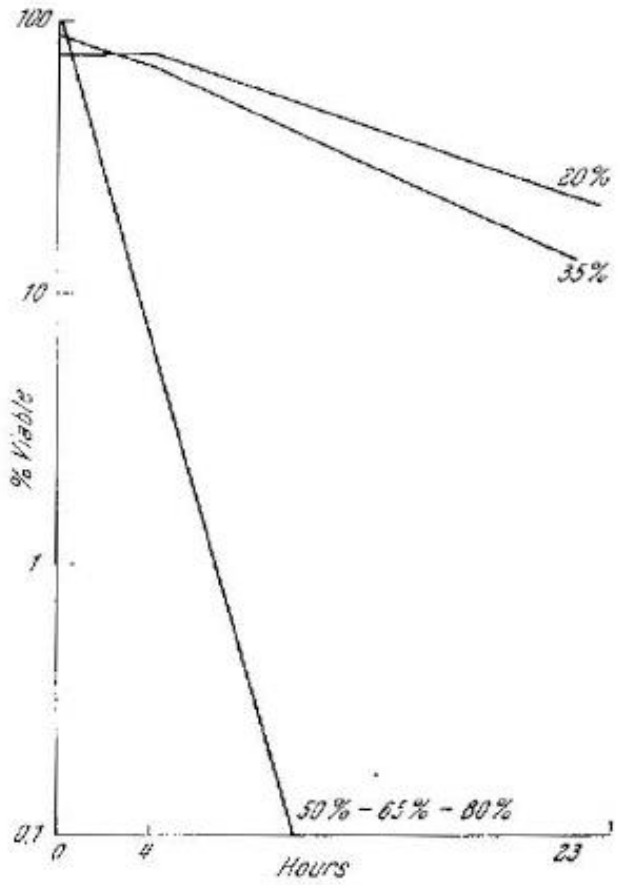


Fig. 3. Viable decay of airborne influenza virus (PR 8) at 21–24° C.

Harper, GH Airborne micro-organisms: survival tests with four viruses Journal of Hygiene (London) 1961 v59 p479

Leading virologists Peter Wright, Gabrielle Neumann and Yoshihiro Kawaoka state that low humidity is a critical factor to flu transmission

Virologists Peter Wright[1], Gabrielle Neumann[2] and Yoshihiro Kawaoka[3] state: "The low relative indoor humidity during the winter months is believed to prolong the survival of influenza in aerosols and is believed to be responsible for the seasonal pattern in the northern hemisphere. The most effective spread among humans are aerosols. Most aerosol droplets formed during sneezing or coughing are less than 2 microns in diameter (droplet nuclei), and are preferentially deposited in the lower airways of the lung. Volunteers are readily infected by aerosol transmission. The often sudden onset of epidemics suggests that an infected individual can transmit the virus to a relatively large number of people.[4]

1. Professor Pediatrics, Pathology, Microbiology and Immunology Chief Division of Pediatric Infectious Diseases Vanderbilt University School of Medicine
2. Associate Professor Department of Pathobiological Sciences School of Veterinary Medicine University of Wisconsin
3. Professor Department of Microbiology and Immunology University of Tokyo

4. Fields Virology 2007 Fifth Edition Page 1704

Low Indoor Humidity Increase Airborne Droplet Nuclei Levels

- **Viruses Evaporate faster in Low Humidity levels (technically low grains[1]) thus creating More Droplet Nuclei.**
- **Low humidity allows droplet nuclei to stay airborne longer as the droplets do not absorb extra water weight which would cause them to fall to the ground.**
- **Indoor Air currents both created by HVAC systems and people movement and their heat plumes assure that droplet nuclei will remain airborne nearly *indefinitely* indoors.**
- **This allows HVAC systems to redistribute droplet nuclei viruses throughout the building to infect more occupants.**

1. See my January 2010 article about this @ Greencleanair.com

Correlation between low indoor humidity and increases in influenza morbidity and mortality

1. **Indoor wintertime humidity levels in the Northern Hemisphere especially in North America and Europe are between 15-35%.**
2. **Since influenza loves low humidity air, the correlation between low indoor humidity and increases in influenza morbidity and mortality is logical given the correlation of airborne droplet nuclei creation and available contagion to infect humans.**
3. **What now establishes how "flu season" is created is a new study[1] by the University of Virginia's Robert Davis linking the correlation between dry cold arctic air masses which descend upon New York City and subsequent flu deaths 17 days later.**

1. Davis, Robert The Impact of Weather on Influenza and Pneumonia Mortality in New York City, 1975–2002: A Retrospective Study PLoS 2012 v7 e-page 34091.

This open source study is available @ GreenCleanAir.com

The Answer, My Friend, Is Blowing in the Wind* (Blame Canada!**)

Scientific Study: **17** days after **Dry & Cold** Canadian Air hits New York City: Influenza deaths <u>increase</u>

Cold & Dry Arctic air masses descend upon NYC. Cold and dry Outdoor air is sucked indoors lowering indoor humidity.

Cold & Dry air allows efficient <u>Outdoor</u> flu transmission. More <u>outdoor</u> Flu Viruses can live longer to infect humans both outdoors and be sucked indoors.

Cold & Dry air is sucked into buildings increasing <u>Indoor</u> flu transmission. Heated air lowers Indoor Humidity even more. Indoor Flu Viruses can live longer to infect more naïve humans.

Davis, Robert The Impact of Weather on Influenza and Pneumonia Mortality in New York City, 1975–2002: A Retrospective Study 2012 PLoS v7 e-page 34091

*© Bob Dylan **© Southpark Creations

This open source study is available @ GreenCleanAir.com

What technologies can sterilize, capture and/or kill (inactivate) airborne flu viruses?

1. Being removed from indoor air by exhaust vents to outdoor air
2. Indoor Relative humidity above 40% at 70º (45% even better)
3. Captured by Gasket Sealed Nano-Rated HEPA Filters
4. Exposure to Ultraviolet Light- “C” band, “germicidal” photons

Ultraviolet Light can “Kill”/Sterilize/ inactivate this % of Flu Viruses:

UVR Rating	%Viruses Killed/Sterilized/Inactivated
6- (75mw)	4.4%
7- (100mw)	5.8%
8- (150mw)	8.5%
10- (500mw)	25.7%
13- (2000mw)	69.5%
15- (4000mw)	90.7%
16- (5000mw)	94.9%

mw=Microwatt

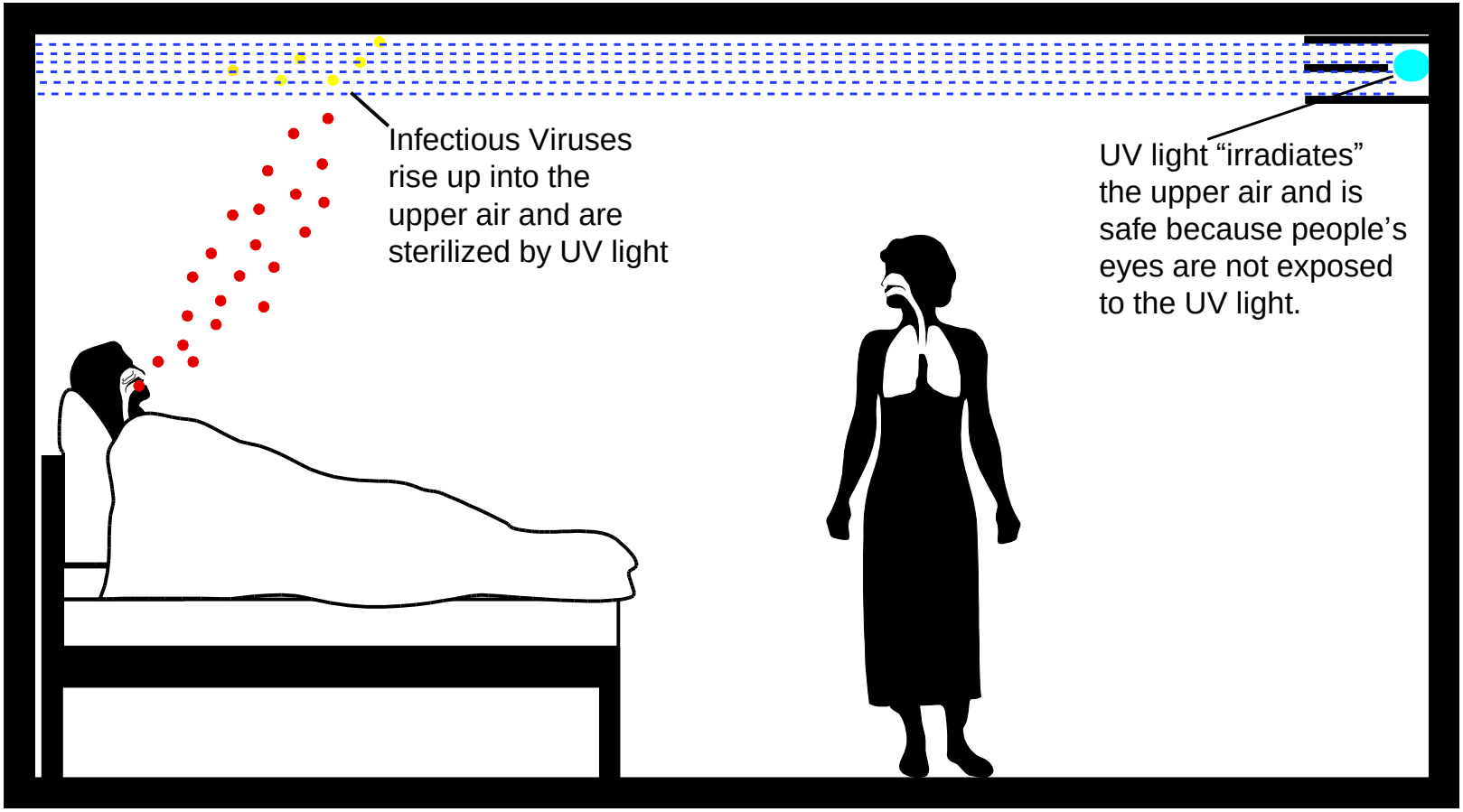
Kowalski, Wladyslaw Modeling Immune Building Systems for Bioterrorism Defense Journal of Architectural Engineering, 2003 Vol. 9, page 86

More information on this study is available @ GreenCleanAir.com

What is Ultraviolet Light and how does it work?

- **Ultraviolet Germicidal (germ-killing) light is UV light in the "C" band (254 nanometers). It is invisible and is mostly filtered out our of sunlight before it reaches earth's surface. UV-C light Sterilizes germs by destroying the "T" bonds in their DNA or RNA. This prevents them from reproducing and they die soon after.**
- **UV was artificially created in the 1890's and later commercially used to kill waterborne viruses & bacteria in France in 1909 for safe drinking water in Paris and other cities.**
- **By the 1930's Duke University surgeons were using in in operating rooms to reduce airborne bacterial and viral infections. In the 1930's and 1940's UV light was used in schools to successfully prevent airborne measles epidemics and in hospitals to prevent airborne disease transmission in the nurseries.**

How Upper UV Room works to prevent airborne virus transmission



Veteran's Hospital 1957 Flu Pandemic Upper Room UV Study: 100% Effective

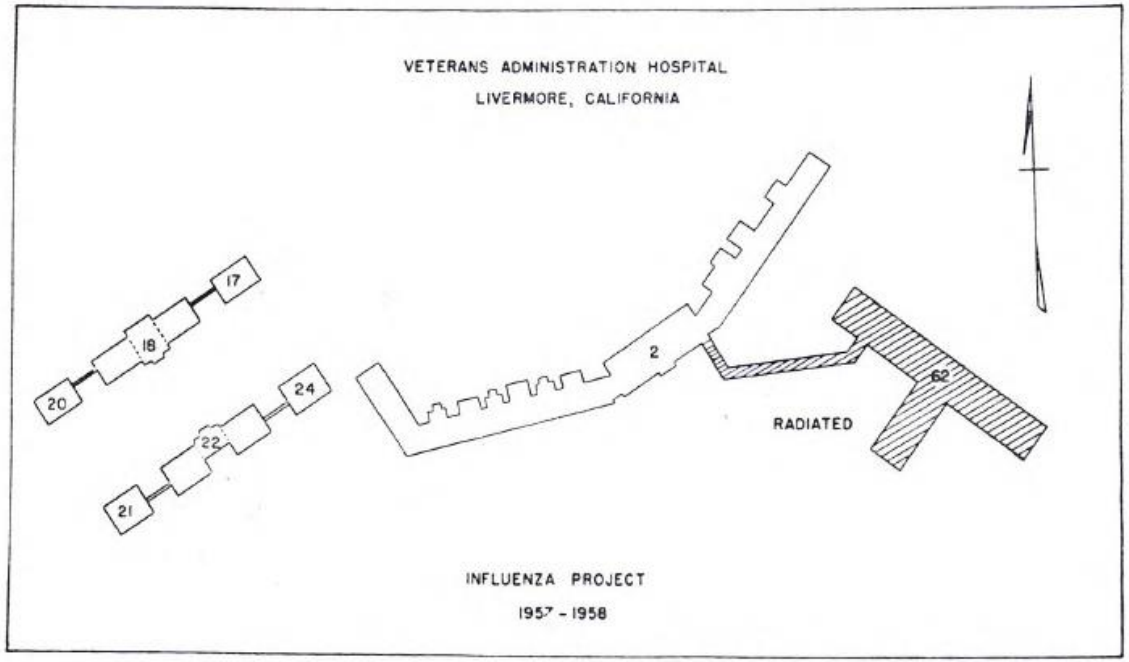


FIG. 4. Illustrates the plan of the hospital grounds and depicts the area which was isolated from the rest of the hospital by radiant disinfection of the upper air of all rooms and corridors.

TABLE 9

NUMBER OF PATIENTS WITH ACUTE RESPIRATORY SYMPTOMS

Phase 2, November 16, 1957–March 16, 1958

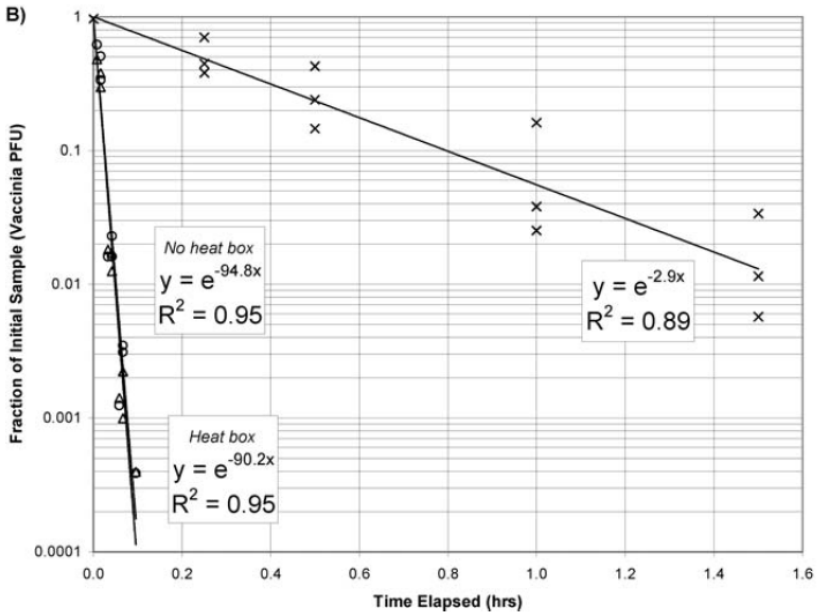
Week of	Radiated		Nonradiated	
	Influenza	Other	Influenza	Other
12/15	0	0	2	0
12/22	0	1	1	5
12/29	0	0	0	8
1/5	0	2	7	4
1/12	0	0	18	6
1/19	0	0	10	4
1/26	0	1	1	1
	0		**39**	

McLean, RL International Conference on Asian Influenza at The National Institutes of Health 1960 p36

Harvard Professor James McDevitt 2008 upper room UV virus Experiment

Professor McDevitt installed upper room UV lights to replicate the success of the 1957 Flu pandemic.

"Air disinfection using upper-room (UV) light can lower the airborne concentrations of infective organisms in the lower part of the room, and thereby control the spread of airborne infections among room occupants.
These data demonstrate that upper-room UVC has the potential to greatly reduce exposure to susceptible viral aerosols.
These data may also be relevant to influenza, which also has improved aerosol survival at low RH."



99.9% of airborne viruses were killed (inactivated) in just 6 minutes (.1 hour).

Inactivation of Poxviruses by Upper-Room UVC Light in a Simulated Hospital Room Environment McDevitt, James 2008 PloS ONE v3 e-page 3186.

This open source study is available @ GreenCleanAir.com

Harvard Professor James McDevitt 2012 upper room UV virus Experiment

Again in 2012, Professor McDevitt published the results of installing upper room UV lights to replicate the success of the 1957 Flu pandemic experiment by Dr. RL McLean and this time he used airborne influenza viruses.

"Using our experimental system, we measured influenza reductions as low as 98.2% by comparing samples with the UV light on to subsequent samples control samples with the UV light off.

This work provides an essential scientific basis for designing and utilizing effective upper-room UV-C light installations for the prevention of the airborne transmission of influenza."

Aerosol Susceptibility of Influenza Virus to UV-C Light McDevitt, James et al. Applied Environmental Microbiology 2012 v78 p1666.

This study is available @ GreenCleanAir.com

UCLA School of Medicine UV Experiment to kill Influenza-100% Effective

Inactivation of Airborne Viruses by Ultraviolet Irradiation

MARCUS M. JENSEN

Department of Medical Microbiology and Immunology, School of Medicine, University of California, Los Angeles, California

Received for publication 11 May 1964

TABLE 1. *Inactivation of viral aerosols during passage through a helical baffled UV cell**

Virus	Concn of virus suspension†	Amt of viral suspension dispensed per min	Air-flow rate through UV cell	No. of virus PFU collected per ft³ of air with		Percentage of virus inactivated by UV light
				UV off	UV on	
		ml	ft³/min			
Adenovirus	3.4×10^8	0.144	100	29,235	913	96.88
			200	28,016	2,436	91.31
Coxsackie B-1	4.0×10^7	0.143	100	10,755	5	99.95
			200	9,000	225	97.50
Influenza A	1.0×10^7	0.145	100	920	0	>99.90
			200	690	0	>99.86
Sindbis	7.5×10^6	0.150	100	5,644	26	99.53
			200	3,793	124	96.73
Vaccinia	1.0×10^8	0.128	100	27,522	0	>99.99
	2.0×10^7	0.142	200	2,265	0	>99.96

0 Infectious Flu Viruses at 100 & 200 cubic feet per min (cfm)

Jensen, Marcus INACTIVATION OF AIRBORNE VIRUSES BY ULTRAVIOLET IRRADIATION Applied Microbiology 1964 v12 p418

This study is available @ GreenCleanAir.com

Mechanical Air Filters can trap this % of Influenza Viruses:

MERV Rating	%Viruses Arrested (captured)
1-5	1-5%
6	6.2%
7	7%
8	11%
10	12%
13	46%
15	71%
16	76%
17 (HEPA)	99.9%

Kowalski, Wladyslaw Modeling Immune Building Systems for Bioterrorism Defense Journal of Architectural Engineering, 2003 Vol. 9, page 86

More information on this study is available @ GreenCleanAir.com

Viruses can be captured & sterilized with a combination of MERV Filters & URV rated UV-C Light

- **Adding filters and UV together in successive layers can provide a lethal force to both prevent the recirculation and reduce the levels of airborne viruses in occupied spaces.**
- **A MERV 10 filter alone captures only 10% or flu viruses whereas adding a Ultraviolet rating of URV 10 triples that total single pass capture/sterilization to 35%.**
- **A MERV 13 filter plus a URV 13 UV light rating can have an 84% capture/sterilize rate for influenza. That is a very achievable goal for any indoor space.**
- **Adding additional UV lamps to an URV 16 level combined with a MERV 16 rated filter can achieve a total single pass capture/ sterilize/inactivation rate of 98.8% for influenza.**

MERV rated filters & UV lights prevent airborne influenza

Table 1. Filtration Rates of Design Basis Biological Weapon Agents

		Filter Model and Removal Rates, Fraction						
Pathogen	Mean size, μm	MERV 6	MERV 7	MERV 8	MERV 10	MERV 13	MERV 15	MERV 16
Influenza	0.098	0.062	0.07	0.11	0.12	0.46	0.71	0.76

Table 2. Ultraviolet Germicidal Irradiation Kill Rates of Design Basis Biological Weapon Agents

		ULTRAVIOLET GERMICIDAL IRRADIATION KILL RATES, FRACTION						
Pathogen	Rate constant ($cm^2/\mu W$-s)	URV 6 75 $\mu W/cm^2$	URV 7 100 $\mu W/cm^2$	URV 8 150 $\mu W/cm^2$	URV 10 500 $\mu W/cm^2$	URV 13 2000 $\mu W/cm^2$	URV 15 4000 $\mu W/cm^2$	URV 16 5000 $\mu W/cm^2$
Influenza	0.001187	0.044	0.058	0.085	0.257	0.695	0.907	0.949

Table 3. Combined Removal Rates for Biological Weapon Agents

	FILTRATION AND ULTRAVIOLET GERMICIDAL IRRADIATION REMOVAL RATES, FRACTION						
Pathogen	MERV 6 URV 6	MERV 7 URV 7	MERV 8 URV 8	MERV 10 URV 10	MERV 13 URV 13	MERV 15 URV 15	MERV 16 URV 16
Influenza	0.10	0.12	0.19	0.35	0.84	0.97	0.988

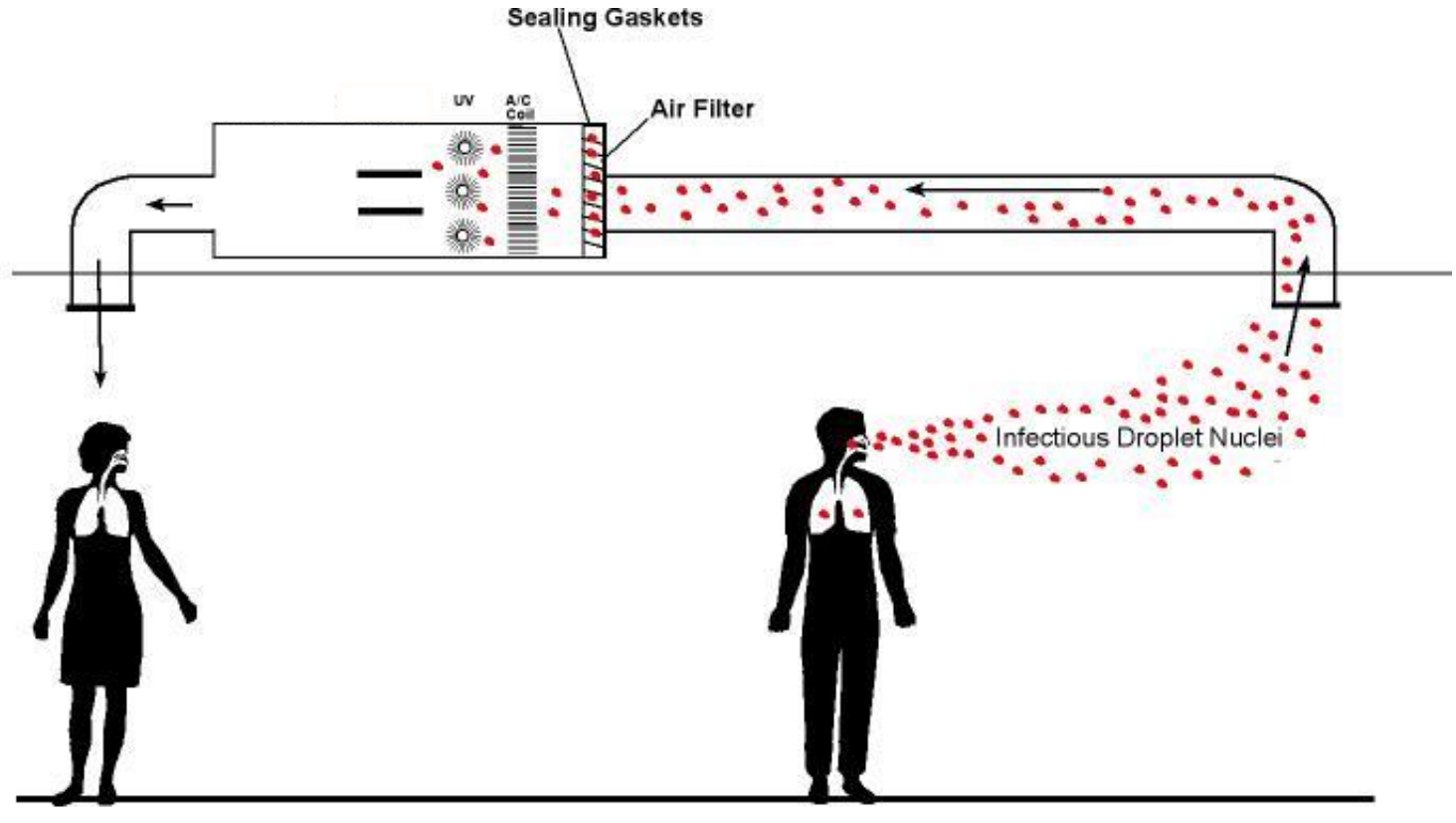
Kowalski, Wladyslaw Modeling Immune Building Systems for Bioterrorism Defense Journal of Architectural Engineering, 2003 Vol. 9, page 86

More information on this study is available @ GreenCleanAir.com

Combined UV Light & Filtration Capture/ Kill/Sterilize this % of Flu Viruses:

MERV & UVR Combined	%Viruses Killed/Sterilized
6	10%
7	12%
8	19%
10	35%
13	84%
15	97%
16	98.8%

HEPA Air Filters, UV Lights can Kill, Sterilize & Capture Viral Droplet Nuclei



Cases of Ultraviolet Lights Preventing Indoor Virus transmission and infection

1. Germantown Friend's School 1942. Am J Public Health Nations Health. 1943 (Measles)
2. Livermore Veterans Hospital-1957. American Review of Respiratory Diseases. 1961 (1957 Flu Pandemic)

Japanese Hospital Humidity Guidelines

Table 1. An example of environmental control recommendations for hospitals in Japan. Used with permission (translated and slightly edited) from the Human and Society Environment Science Laboratory Co. Ltd, Japan (http://www.h-and-s.biz/index2.htm).

		summer		winter	
section	location	dry-bulb temperature (°C)	RH (%)	dry-bulb temperature (°C)	RH (%)
hospital ward	patient bedroom[a]	24–26–27	50–60	22–23–24	40–50
	nurse station	24–26–27	50–60	20–22	40–50
	day room	26–27	50–60	21–22	40–50
outpatient department	consulting room[b]	26–27	50–60	22–24	40–50
	waiting room	26–27	50–60	22–24	40–50
	dispensary	25–26	50–55	20–22	40–50
	ER	23–24–26	50–60	22–26	45–55–60
central medical care areas	operation room	23–24–26	50–60	22–26	45–55–60
	recovery room	24–26	50–60	23–25	45–50–55
	ICU	24–26	50–60	23–25	45–55–55
	birthing room[c]	24–25–26	50–60	23–25	45–55–55
	newborn baby room	26–27	50–60	25–27	45–55–60
	general survey room	25–26–27	50–60	20–22	40–50
	X-ray studio	26–27	50–60	24–25	40–50
	X-ray operation room[d]	25–26	50–60	20–22	40–50
	hydrotherapy treatment room[e]	26–27	50–65	26–28	50–65
	dissection room	24–26	50–60	20–22	40–50

Julian Tang , MD, PhD. J. Royal Soc. Interface (2009) v6, pS737

This study is available @ GreenCleanAir.com

Now Liquid Desiccation systems can produce Clean Humidity

- **New Patented Liquid Desiccant systems can add humidity to the air through micro-pores.**
- **This solves the problems of bacterial and fungal contamination that current steam and water spray humidification systems have. These systems can cause downstream contamination in the ductwork when droplets fall out and wet the surfaces.**
- **See my May 2010 article in Engineered Systems for more information @GreenCleanAir.com.**

Public Health Officials advice on preventing the Flu

1. **Wash your hands.**
2. **Cover your cough.**
3. **If you're sick, stay home.**
4. **Get a Flu vaccination**

This advice doesn't address the problem of studies showing that **up to 40%** of **infected influenza carriers** have **no symptoms**.

It also doesn't address both human airway aerosolization and toilet water flush aerosolization of viruses. These both are critical modes of airborne infectious disease transmission within indoor spaces.

Can Hand washing prevent flu transmission? CNN's Elizabeth Cohen challenged the CDC

In my June 2009 EPA Flu presentation, I said: "**Since your fingers can't touch your lungs, washing your hands won't likely prevent flu viruses from entering deep into your lungs**." I did this to indirectly challenge the CDC's recommendation, widely heralded by the media that, aside from a flu shot, the best advice to prevent you from getting the flu was to "wash your hands". I knew that there was **no** published scientific study **anywhere** which showed that someone with flu viruses on their fingers could infect themselves.

In September 2009, CNN Medical reporter Elizabeth Cohen was the first correspondent that pressed the CDC to produce the scientific documentation backing up their hand washing/ sanitizing recommendation.

She pressed the CDC to admit that hand washing to prevent influenza flu transmission by self inoculation was **not supported by any peer-reviewed, published papers anywhere**: "We don't have solid data on the effect that hand washing has on the transmission of H1N1 (flu virus)," CDC spokesman Tom Skinner wrote in an e-mail to Ms. Cohen. That "lack of solid data" really means there's no published data or paper or successful experiment showing someone getting the flu by hand inoculating themselves by touching their nose, lips, eye or mouth.

"Some doubt hand washing stops H1N1" CNN Elizabeth Cohen September 24, 2009

More expert dismiss hand washing to prevent flu transmission

In Ms. Cohen's article "Some doubt hand washing stops H1N1" (link below) she posits: "Hand washing: A false sense of security from H1N1? Some infectious disease experts said they're concerned messages from the CDC to wash hands to prevent H1N1 have given people too much faith in hand washing.

'Washing hands really is wonderful for preventing many diseases, such as the common cold, but it's **not very helpful to prevent influenza**,' said Arthur Reingold, professor of epidemiology at the University of California-Berkeley.' 'Everyone's eager to promote hand washing, and certainly it won't do any harm, but to rely on a hand washing as a way to prevent influenza is a serious mistake,' said Reingold.

Dr. Monto is a world renown influenza expert with over 60 peer reviewed & published articles on influenza: 'Don't kid yourself that you're going to protect yourself from the flu completely by washing your hands,' said Arnold Monto, a professor of epidemiology at the University of Michigan School of Public Health."

She also reported: "Dr. Peter Palese, a professor of medicine and infectious diseases at Mount Sinai School of Medicine in New York City, said 'hand washing isn't all that helpful against the flu because the flu isn't like other respiratory diseases. 'The flu virus isn't very stable on the hand,' he said. 'The virus has a lipid membrane that flattens out when it's on your hand, and it gets inactivated."

"Some doubt hand washing stops H1N1" Elizabeth Cohen September 24, 2009

Recommendations to prevent and mitigate airborne flu transmission

1. **Seal your filter rack & HVAC system.**
2. **Get the highest MERV rated filter that your air handling fan can tolerate.**
3. **Put as much UV light within your coil plenum to achieve a 99.9% single pass kill rate along with Upper Room UV.**
4. **Add MERV 17 HEPA Filtration for viral capture and inactivation.**
5. **Install bathroom exhausts 1-12” above the floor behind the toilet to capture aerosolized toilet water. Supply in ceiling.**
6. **Coughing/sneezing occupants wear a mask or stay at home.**

How to Solve “Flu Season”

- Raise Humidity to 45%+
- Increase air changes to 12 per hour
- In-Duct UV
  - Upper Room UV
- Toilet Seat Lowered
  - Exhaust behind & below toilet
- MERV 13
  - +URV 13 UV Lights
  - MERV 17 HEPA (best)

→ Flu Season Mitigated!

Toilet Aerosolization Studies

1959. Infective hazards of Water Closets. Darlow, HM, Bale WR Lancet v6;1(7084) p1196 "Any process involving the splashing or frothing produces droplets, which remain suspended in the air for a variable period depending upon the mass and evaporation-rate of the droplets, and the velocity and direction of the local air currents. Apart from explosive exhalations such as coughs and sneezes, the commonest process predisposing to the formation of infective aerosols must surely be the flushing of a water-closet." More information about this article is available @ GreenCleanAir.com

1975. **Microbial Hazards of Household toilets: Droplet Production and the Fate of Residual Organisms. Gerba, Charles** Applied Microbiology 1975 v2 p229 "It appeared that significant numbers of bacteria and viruses were being absorbed to the toilet porcelain and then eluted during the flushing action… viruses from experiments performed **several days** earlier were still present in the room. Click here for copy @ National Library of Medicine

1985. Method of detecting Viruses in Aerosols. Appl Environ Microbiol. Wallis, C. v50 p1181 Recovered an average of 1500 airborne viruses due to a toilet flush. Click here for copy @ National Library of Medicine

2000 . Survival of Salmonella in bathrooms and toilets in domestic homes following salmonellosis. Barker John, Journal Applied Microbiology 2000 Jul v89 p137 Click here for copy @ Journal of Applied Microbiology

2005. The potential spread of infection caused by aerosol contamination of surfaces after flushing a domestic toilet. **Barker, John** Journal of Applied Microbiology v99 p339. "Aims: to determine the level of aerosol formation and fallout within a toilet cubicle after flushing a toilet contaminated with indicator organisms (viruses) at levels required to mimic pathogen shedding during infectious diarrhea." Airborne viruses were still aerosolized 30 minutes and 60 minutes after the first flush. Click here for copy @ Journal of Applied Microbiology

Airborne Droplet Nuclei Infection Studies

1966. Human Influenza from Aerosol inhalation **Alford, RH** Proceeding of the Society Environmental Microbiological Medicine v22 p800 Found that it took only .6 to 3 viruses to infect "volunteers" with aerosolized influenza. Contrast that with studies showing it took 330 viruses to infect someone nasopharyngeally. More information about this article is available @ GreenCleanAir.com

1970. An Airborne Outbreak of Smallpox in a German Hospital and its Significance with Respect to other Recent Outbreaks in Europe. Bulletin of the World Health Organization. "In a recent outbreak ... detailed epidemiological studies have clearly indicated that 17 of the cases were infected by virus particles disseminated by air over a considerable distance within a single hospital building … several features ... were common similar to a similar outbreak in the Federal Republic of Germany in 1961 in which airborne transmission also occurred. **This open source study is available @ GreenCleanAir.com**

Nosocomial Influenza Infection as a cause of Intercurrent Fevers in Infants. Hall, Caroline Breese Pediatrics. V55 p673 "Six of seven infants shed the virus for 7 to 21 days." More information about this article is available @ GreenCleanAir.com

1979. Indoor Spread of Respiratory Infection by Recirculation of Air. Riley, Richard Bulletin of European Physiopathology Respiratory v15 p699 One measles-infected student went on to infect 28 others in classrooms throughout the school. "The wide distribution of the 28 cases among children who had never occupied the same room as the index patient and the fact that about 70 per cent of the air was recirculated and hence shared by all the children served by the ventilating system, led to the conclusion that measles reached the different classrooms by way of the ventilating system. 93% of the first generation infections could have been prevented by disinfecting recirculated air. This would have aborted the entire outbreak. More information about this article is available @ GreenCleanAir.com

Airborne Droplet Nuclei Infection Studies (cont.)

An outbreak of Influenza aboard a commercial airliner. Moser, MR 1979 American Journal of Epidemiology v110 p1. Of the 53 passengers on the plane, 38 (72%) became infected with the same strain of influenza as a passenger with the flu. "Spread of Influenza is via droplets or droplet nuclei and the period of infectivity of these particles is prolonged by low humidity." More information about this article is available # GreenCleanAir.com

Airborne transmission of Chickenpox in a Hospital. Leclair, JM New England Journal of Medicine v302 p450 Chickenpox patient infected 13 other patients not only through indoor air but through her open window which, like Wang Kaixi, allowed air currents to blow her viruses downwind to infect others. "Her room was at positive pressure with respect to the hall and the outside of the building, these conditions promoted the escape of virus contaminated air. Once in the hall, air, presumably bearing droplet nuclei, was blown into the other rooms of the ward." More information about this article is available @ GreenCleanAir.com

Measles Outbreak in a Pediatric Practice. Bloch, Alan 1985 Pediatrics. V75 p676 "Airflow studies demonstrated the droplet nuclei generated in the examining room used by the index patient were dispersed throughout the entire office suite. (Large) droplet spread is unlikely because three of the patients with secondary cases were never in the same room as the source patient. More information about this article is available @ GreenCleanAir.com

A Measles Outbreak at University Medical Settings Involving Health Care Providers Sienko, DG American Journal of Public Health 1987 v77 p1222 "In 1985, a measles outbreak involved 14 students and non-student contacts in Michigan. Eight transmissions occurred at university medical facilities; five of these were likely airborne transmissions. Medical students and a medical resident were involved in the outbreak's propagation." More information about this article is available @ GreenCleanAir.com

Selected Viruses of Nosocomial Importance. 1998 Hospital Infection, 4th Edition. "Influenza A and B viral infections are among the moist communicable diseases of humans. Person to person transmission is believed to take place primarily by droplet nuclei. These aerosols help account for the explosive nature of influenza outbreaks, since, in a closed environment, one infected person can potentially infect large numbers of susceptible persons." More information about this article is available @ GreenCleanAir.com

Airborne Droplet Nuclei Infection Studies (cont.)

2004. Airborne Transmission of Communicable Infection-the Elusive pathway. Roy, CJ; Milton, DK. New England Journal of Medicine v350 p1710 "The current paradigm, as initially described by Charles Chapin in 1910, supports the belief the most communicable respiratory infections are transmitted by means of large droplets over short distances or through the contact with contaminated surfaces. What underlies the low repute of airborne transmission? First, the two diseases whose aerosol transmission is most widely acknowledged, measles and tuberculosis, have been largely controlled with vaccination or drug therapy. As a result, the impetus to understand the aerobiology of infectious diseases has faded. Second, contamination of water, surfaces and large droplet sprays can be easily detected. It is difficult, however, to detect the contaminated air, because infectious aerosols are usually extremely dilute, and it is hard to collect and culture fine particles. But the **reduction of airborne transmission of influenza by means of air sanitation in school could prove important with the emergence of the next pandemic influenza virus**."

2005. Viral Load Distribution in SARS Outbreak. Chu, CM. Emerging Infectious Diseases 2005 Dec;11(12):1882-86.. Showed how Amoy Garden victims of Wang Kaixi's SARS virus had higher levels of viruses in their nasal passages depending on how close they were to his apartment.

2006. Review of Aerosol transmission of Influenza A Virus. Tellier, Raymond. Emerging Infectious Diseases v12 p1657-62. "Large droplet transmission as the predominant mode by which influenza viruses is acquired. As a consequence of this opinion, protection against infectious aerosols is often ignored for influenza. This position contradicts the knowledge on influenza viruses transmission accumulated in the past several decades. Indeed, there relevant chapters of many reference books, written by recognized authorities, refer to aerosols (droplet nuclei) as an important mode of transmission for influenza … human cases of avian influenza were acquired by exposure to an aerosol (droplet nuclei) since large droplets would not have delivered the virus to the lower respiratory tract." See also "Review: Aerosol transmission of influenza" by Raymond Tellier Journal of the Royal Society 2009.

More information about these articles is available @ GreenCleanAir.com

Airborne Droplet Nuclei Infection Studies (cont.)

2006. Disease Mitigation Measures in the Control of Pandemic Influenza. Ingesby, TV. Biosecurity and Bioterrorism v4 p366-75. "There are no data to demonstrate that hand-washing deters the spread of influenza within a community. General respiratory hygiene, such as covering one's mouth when coughing and using disposable paper tissues, is widely believed to be of some value in diminishing spread, even though there is no hard evidence that this is so. It has been recommended that individuals maintain a distance of 3 feet or more during a pandemic so as to diminish the number of contacts with people who are infected. The efficacy of this measure is unknown."

2006. Factors involved in the Aerosol transmission of infection and control of ventilation in healthcare facilities. Tang, JW. Journal of Hospital Infection v64 p100. Journal of Hospital Infection Control. "Recent guidelines from the UK review the evidence for influenza transmission more comprehensively ... influenza can become truly airborne. Droplets generated by talking, laughing and sneezing potentially lead to the generation of infectious aerosol (droplet nuclei). The survival of such aerosolized pathogens depends on environmental conditions such as temperature and relative humidity. Long range transmission occurs between distant location and is primarily governed by air flows driven by pressure differences generated by ventilation systems."

More information about these articles is available @ GreenCleanAir.com

Studies on “Flu Season” due to Low Indoor Humidity

1960 Viruses survival as a seasonal factor in influenza and poliomyelitis. Hemmes, JH. Nature v218 p430

1964. Survival of Measles in Air. DeJong, JG. Nature v201 p1054 “Relative humidity indoors might be an important factor in the seasonal variation of measles (virus).”

1976. Survival of airborne influenza virus: effects of propagating host, relative humidity and composition of spray fluids. Schaffer, FL. Archives of Virology 1976 v51 p263-73.

1979. An outbreak of Influenza aboard a commercial airliner. Moser MR. American Journal of Epidemiology Jul;110 p1-6. Of the 53 passengers on the plane 38 (72%) became infected with the same strain of influenza as the sick passenger. “Spread of Influenza is via droplets or droplet nuclei and the period of infectivity of these particles is prolonged by low humidity.”

2006. Factors involved in the Aerosol transmission of infection and control of ventilation in healthcare facilities. Tang, JW. Journal of Hospital Infection Control v64 p100-14. “The survival of such aerosolized pathogens depends on environmental conditions such as temperature and relative humidity.”

2007. Influenza Virus Transmission is Dependent on relative Humidity and temperature. Lowen AC. PLoS Pathology. Oct 19 v3 epage1470-6. “Long term exposure to dry air is likely to affect influenza viruses growth in the upper respiratory tract, and may indeed play a role in influenza seasonality. (Influenza) transmission was highly efficient at low relative humidity levels-20% or 35% .”

More information about these articles is available @ GreenCleanAir.com

Airborne Influenza in Dry Wintertime Indoor Air

Is 50%rh Indoor Humidity One Cure for "Flu Season"?

Environmental Protection Agency

Federal Interagency Committee for Indoor Air Quality

Washington, DC

February 13, 2013

(Updated 1.24.2015)

Steven Welty CIE, CAFS, LEED®, AP

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