

NIOSH Influenza Transmission Research



Flash photo of a human sneeze. Source: Prof. Andrew Davidhazy, School of Photographic Arts and Sciences, Rochester Institute of Technology, Rochester, NY, USA.

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How does influenza spread from person to person?

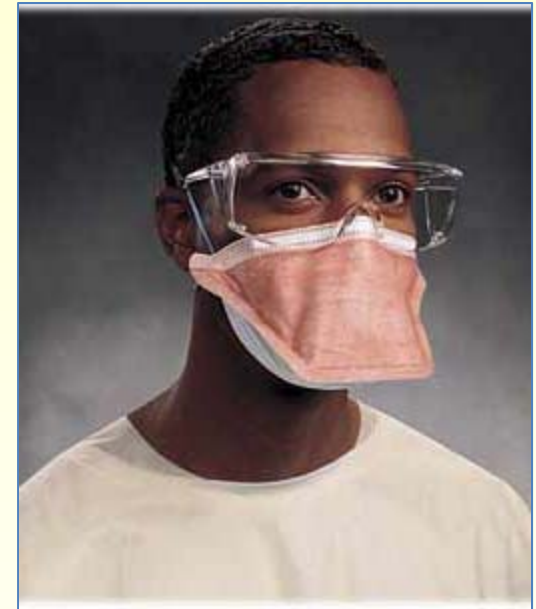
- Influenza may spread by:
 - Direct transfer of secretions, such as by hands.
 - Large ballistic spray drops from coughing and sneezing.
 - Inhaling small airborne particles produced during coughing, sneezing and breathing.
- The relative importance of these routes of transmission is unknown.
- In particular, airborne transmission of influenza by small aerosol droplets over longer distances is controversial.
 - Several studies suggest small aerosol particles can spread the flu, but how important is this route?



Emergency hospital during 1918 influenza epidemic, Camp Funston, Kansas USA (source: National Museum of Health and Medicine, AFIP).

Do healthcare workers need respiratory protection during an influenza pandemic?

- During a pandemic, healthcare workers would be at extremely high risk of exposure.
- If influenza is spread by small airborne particles, a surgical mask will not protect workers, and a respirator is needed.
- However, respirators can be hot, uncomfortable and time-consuming, and they can make patient care more difficult.
- To help answer this question, NIOSH is studying the exposure of healthcare workers to airborne influenza and the efficacy of different protective measures.



(Photo from Kimberly-Clark)

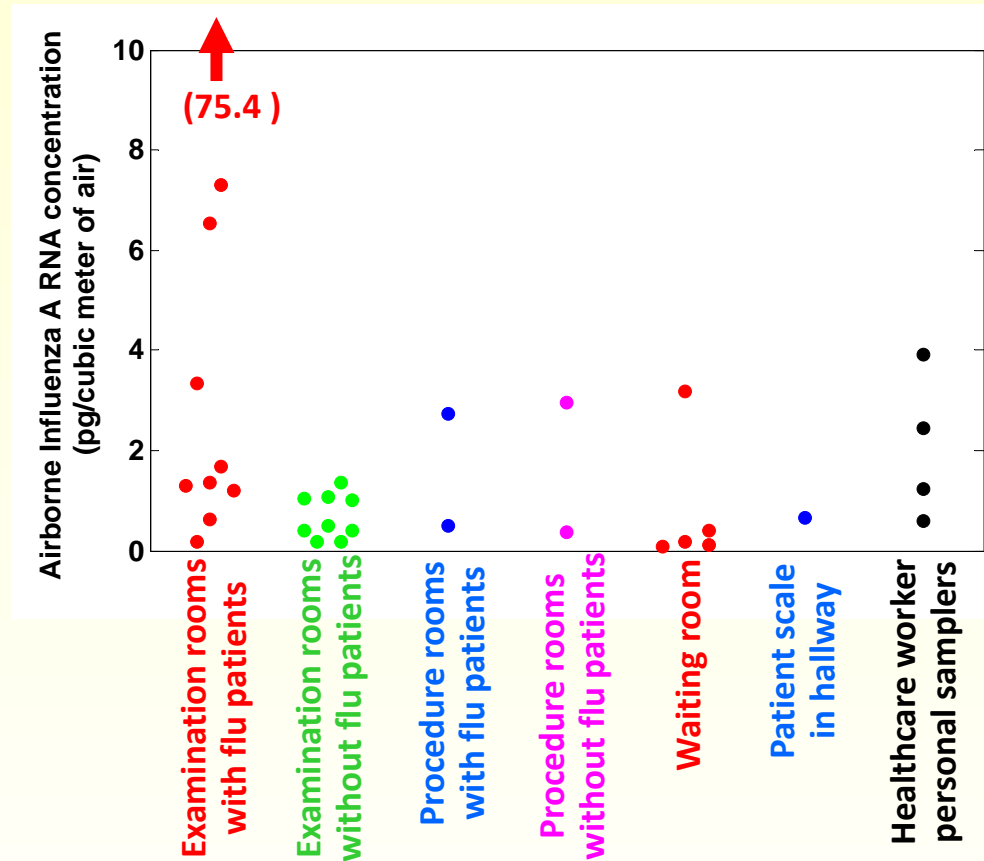
How much airborne influenza is there in healthcare facilities during flu season?

- Two locations studied:
 - Hospital Emergency Department.
 - Urgent Care Clinic.
- Airborne particles were collected using NIOSH aerosol samplers mounted on tripods and worn by healthcare workers.
- Adult patients and visitors with respiratory symptoms were screened for influenza.
- Aerosol samples were analyzed using quantitative PCR.
 - PCR looks for the genetic material of the influenza virus.
 - Does not tell you if the virus is alive or dead.



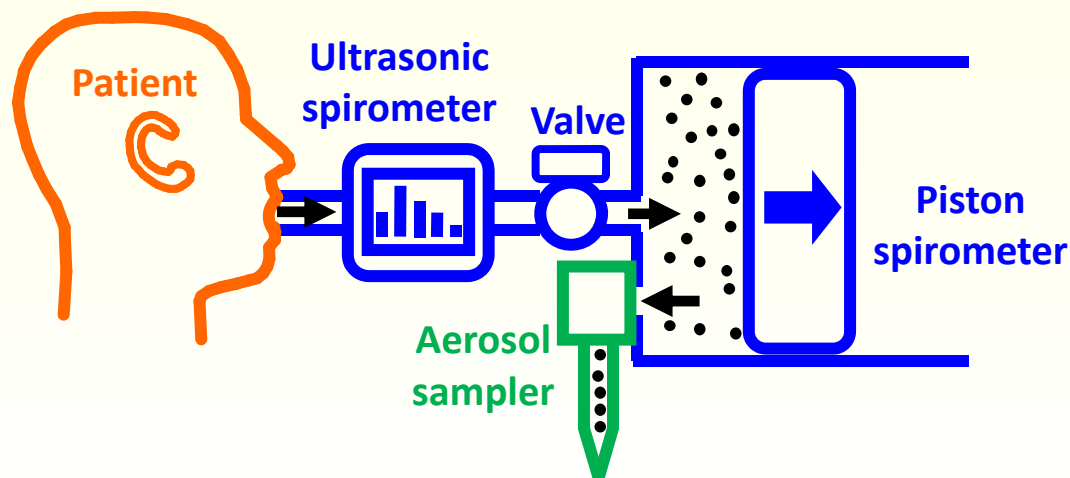
Conclusions from aerosol sampling in healthcare facilities

- Airborne particles containing influenza virus were found throughout both facilities.
- Exposure levels were highest in the locations and at times when the patient loads were heaviest.
 - On the busiest day at the Urgent Care clinic, airborne influenza virus was detected in every room.
- 40% to 50% of the influenza virus was in particles $\leq 4 \mu\text{m}$.
 - Small enough to stay airborne.
 - Easily inhaled.
 - Particles are respirable (can reach alveolar region of lungs).



How much airborne influenza is expelled by patients while coughing?

- Cough aerosol particles produced by 47 influenza patients were collected.
- 84% of cough aerosols contained influenza RNA.
- 65% of influenza RNA was in respirable particles.
- 39% of influenza in cough aerosols came from just 3 patients.
- Able to culture influenza from cough aerosols from 2 patients (of 18 tested).



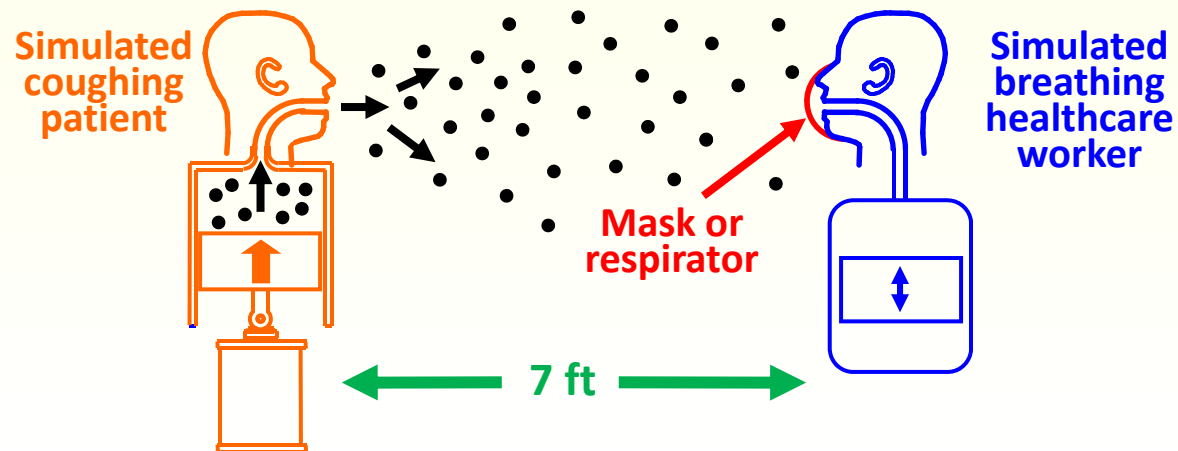
“Why Hospital Staff Catch the Flu” Study

- Respiratory Protection Effectiveness Clinical Trial (ResPECT) is a large multi-hospital study comparing efficacy of N95 respirators to surgical masks against respiratory infections.
- WHSCF “piggy-backs” on ResPECT .
- Measuring influenza on healthcare worker PPE (gloves, masks, N95 respirators) and in air and surface samples.
- Results will be compared to the incidence of influenza in healthcare workers in the ResPECT study.



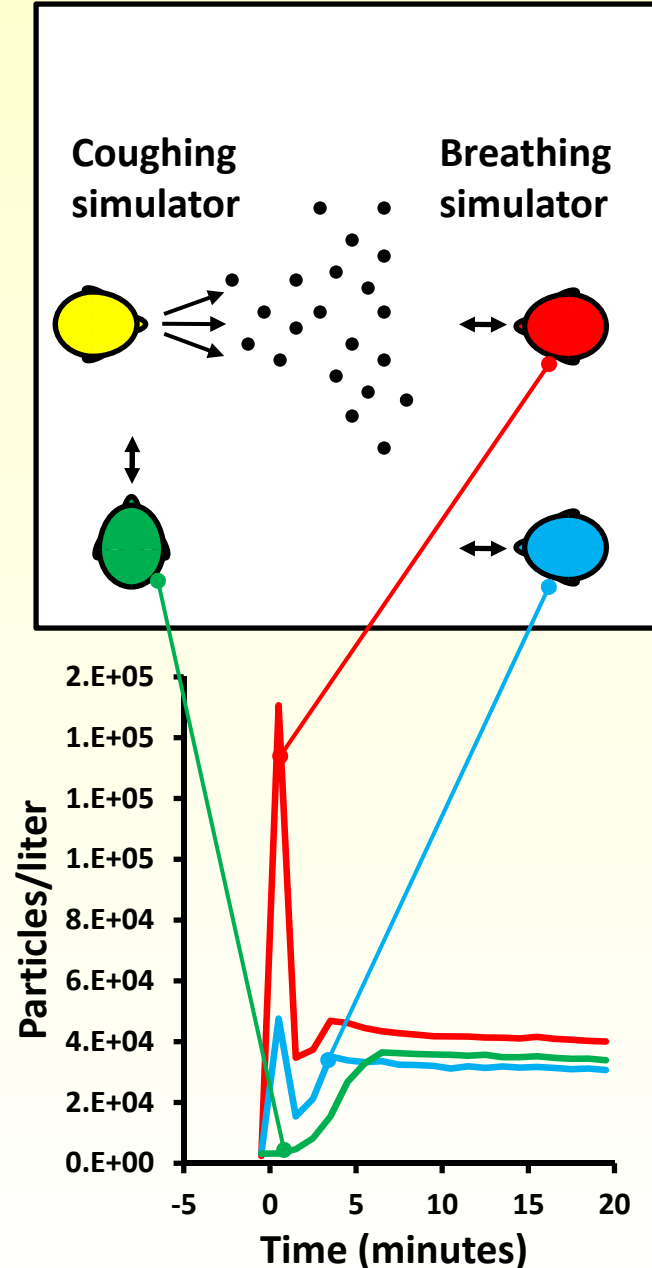
How do cough aerosols spread in an examination room?

- A 10 ft x 10 ft x 8 ft tall environmental chamber is used to model a medical examination room.
 - Coughing aerosol simulator to simulate infectious patient.
 - Breathing simulator to simulate healthcare worker.
- Breathing simulator can be outfitted with a surgical mask, N95 respirator, or other types of personal protective equipment.
- Room temperature, humidity & ventilation can be controlled.
- Room has UV lights & HEPA filtration for disinfection.



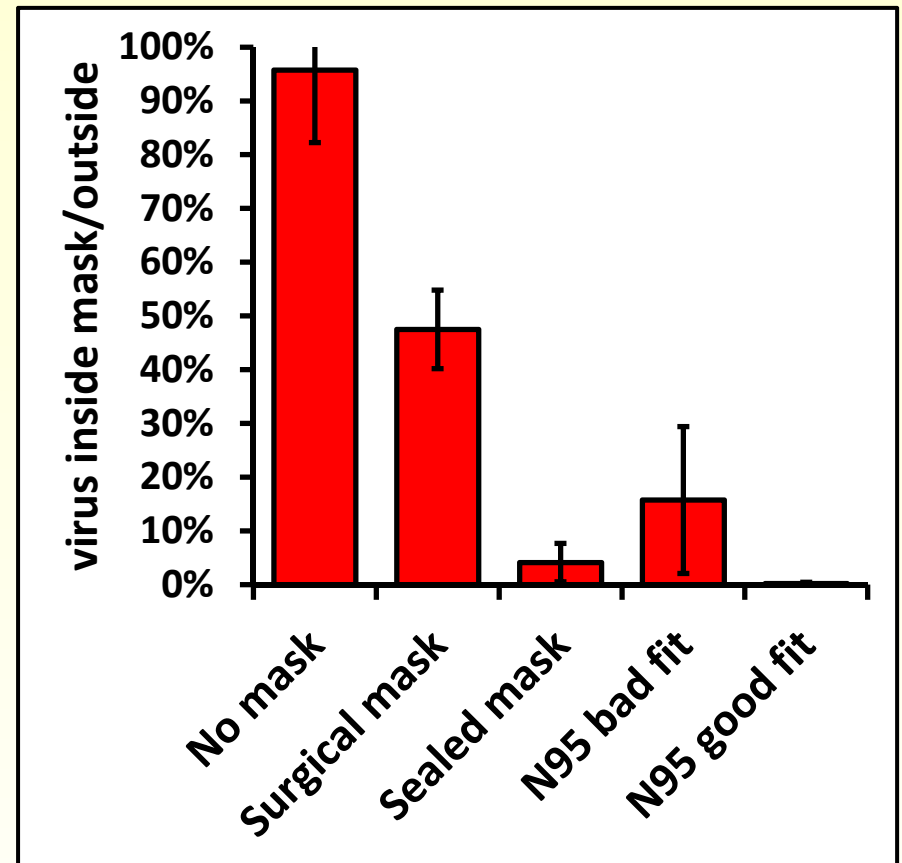
Exposure to cough aerosol particles

- This plot shows the concentration of 0.3-0.4 μm aerosol particles inhaled by the breathing simulator at different locations in the room.
- Immediately after a cough, a worker directly in front of the patient is exposed to a concentrated plume of aerosol particles.
- However, after about 5 minutes, the cough aerosol has spread throughout room, and anyone inside is exposed.



Influenza virus inhaled while wearing no mask, surgical mask & N95 respirator

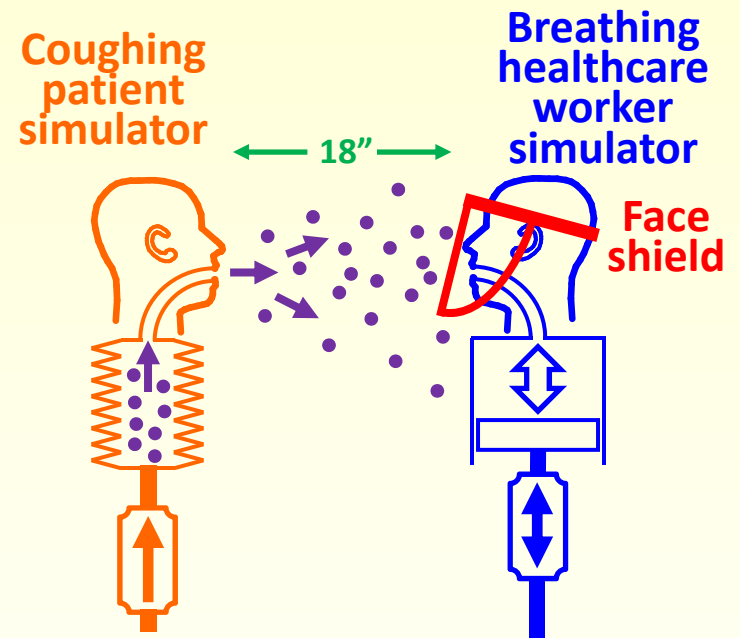
- Unsealed surgical mask (as normally worn) allowed almost half of the virus to be inhaled.
- Sealing the mask blocked most of the virus, showing that most of the leakage is due to a poor face seal.
- N95 respirator with face seal leaks admitted about 16% of the virus.
- N95 respirator with good face seal blocked virtually all of the influenza virus from being inhaled.



Plot shows the concentration of live virus inside the mask or respirator compared to outside.

Face shields reduce but do not eliminate cough aerosol exposure

- Influenza-laden particles 0.1 μm to 100 μm in diameter were coughed toward the breathing simulator.
- Face shield blocked 95% of the initial exposure to virus.
 - Reduced respirator surface contamination.
- However, smaller particles were able to go around the faceshield and be inhaled.
- Since smaller particles can remain airborne, a significant exposure can occur over time.

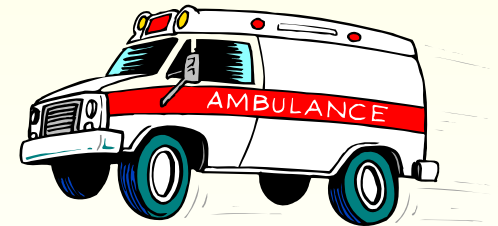


UV for Respirator Reuse & Ambulance Disinfection during a Pandemic

- During a pandemic, a shortage of disposable respirators is possible.
- Ambulances need to be quickly disinfected between patients.
- One option may be to use ultraviolet germicidal irradiation (UVGI) to disinfect respirators and ambulances.
- UVGI leaves no chemical residue and would potentially be quick and easy to use.
- NIOSH is now studying the feasibility of this approach.



(Photo from AO Safety)



More information on influenza-related research at NIOSH is at
<http://www.cdc.gov/niosh/topics/flu/activities.html>
or email me at windsley@cdc.gov

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NIOSH breathing simulator

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