Measurements of airborne influenza in an urgent care clinic

and

Efficacy of masks and N95 respirators against cough aerosols in a simulated examination room

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Measurements of airborne influenza in an urgent care clinic

Objective: To measure the amount and locations of airborne influenza RNA and compare it to the number of influenza patients in a clinical setting.

Aerosol sampling was conducted at the West Virginia University Urgent Care clinic in Morgantown, West Virginia, USA during February 2009.

Aerosol samples were collected on 10 days from 3:30 PM to 8:30 PM and one day from 8:30 AM to 1:30 PM.
Aerosol sampling

- NIOSH two-stage bioaerosol cyclone sampler.
  - Separates aerosol particles into three size fractions.
- NIOSH aerosol samplers were placed in pairs on tripods as stationary samplers.
- Aerosol samplers also were worn by two healthcare workers each night as personal samplers.

Diagram:
- Filter
- Inlet
- 1st stage (15 ml centrifuge tube)
- 2nd stage (1.5 ml centrifuge tube)
Stationary aerosol samplers were placed in pairs on tripods 102 and 152 cm (40" and 60") above floor.
- 3 tripods in waiting room.
- 1 tripod in each of 6 exam rooms.
- 1 tripod in each of 2 procedure rooms.
- 1 tripod next to patient scale in hallway.
- Samplers in examination rooms were placed approximately 1.8 m (6 feet) from examination tables.
- Each night, 2 personal aerosol samplers and 24 stationary aerosol samplers were deployed.
Patient screening for influenza

- Adult patients and visitors with respiratory symptoms were screened for influenza using rapid test with PCR follow-up.
  - 39 of 41 adults tested.
  - 11 were positive for influenza.

- Children were not screened by us, but if they were tested by their physician, the results were provided to us.
  - 10 of 29 children tested.
  - 5 were positive for influenza.

- Examination and procedure rooms occupied by patients and visitors were tracked.

- Health care workers were tested for influenza before donning aerosol samplers.
Influenza detection in aerosol particles

- Aerosol samples were evaluated for influenza A and B using real-time quantitative PCR.
- One-Step RT-PCR kit was used with primers and probes designed for the CDC Real-time RT-PCR Assay for Detection and Characterization of Influenza.
- Target was influenza matrix gene M1.
- We did not attempt to determine infectivity.
Influenza patients and positive samplers

- 264 stationary samplers and 22 personal samplers deployed.
- 17% of stationary samplers and 19% of personal samplers positive for influenza A RNA.
- 1% of stationary samplers and 0% of personal samplers positive for influenza B RNA.
- On day 3, 79% of samplers and all rooms were positive for influenza A RNA.
- Correlation coefficient between influenza-positive patients and samplers was 0.77
Size of airborne particles containing influenza A virus RNA

- Personal sampler draws air at 2 liters/minute
- Particle sizes
  - tube 1, ≥ 5 µm
  - tube 2, 2 to 5 µm
  - filter ≤ 2 µm
- 47% of influenza A RNA was in particles ≤ 5 µm

- Stationary sampler draws air at 3.5 liters/minute
- Particle sizes
  - tube 1, ≥ 4 µm
  - tube 2, 1 to 4 µm
  - filter, ≤ 1 µm
- 41% of influenza A RNA was in particles ≤ 4 µm

Respirable size range (can reach alveolar region of lungs).
Relative concentrations of influenza A

- Highest concentrations seen in exam rooms.
  - Patients spent most of their time in exam rooms.
  - Waiting room large & had high air exchange rate.
- 81% of exam and procedure rooms containing a confirmed influenza patient had airborne influenza A RNA.
- 15% of rooms with no confirmed influenza patients also contained airborne influenza A RNA.
- Healthcare worker exposure levels were similar to those seen in exam and procedure rooms.
Conclusions

Airborne particles containing influenza RNA can be found throughout a typical healthcare clinic during influenza season.

Much of the viral material is contained in particles small enough to spread throughout waiting and patient rooms and to be inhaled deeply into the respiratory tract.

Exposure levels were highest when patient loads were heaviest.
Efficacy of masks and N95 respirators against cough aerosols in a simulated exam room

- Objective is to simulate exposure of a healthcare worker to aerosol from a coughing patient.
- Simulated examination room contains:
  - Cough aerosol simulator to represent a coughing patient.
  - Breathing mannequin to simulate a healthcare worker.
  - Aerosol particle counters to monitor particle spread.
Particles inhaled while wearing no mask, surgical mask & N95 respirator

- Coughing and breathing systems were 6 feet apart and facing each other.
- Plot shows concentration of 0.3 to 0.4 µm KCl aerosol particles at mouth of breathing mannequin.
- Masks and respirators were sealed to breathing mannequin.
- Surgical mask admitted ~20% of particles.
- N95 blocked virtually all particles.
- Similar results are seen for other masks and respirators and for all positions of the coughing and breathing simulators.
Researchers participating in this project

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The findings and conclusions in this presentation have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.

Special thanks to David Edgell, Michael Flemmer & Larry Lee of NIOSH for their assistance, and the staff of the WVU Urgent Care clinic for their cheerful cooperation during this study.

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