Elastomeric Respirators for Healthcare Workers

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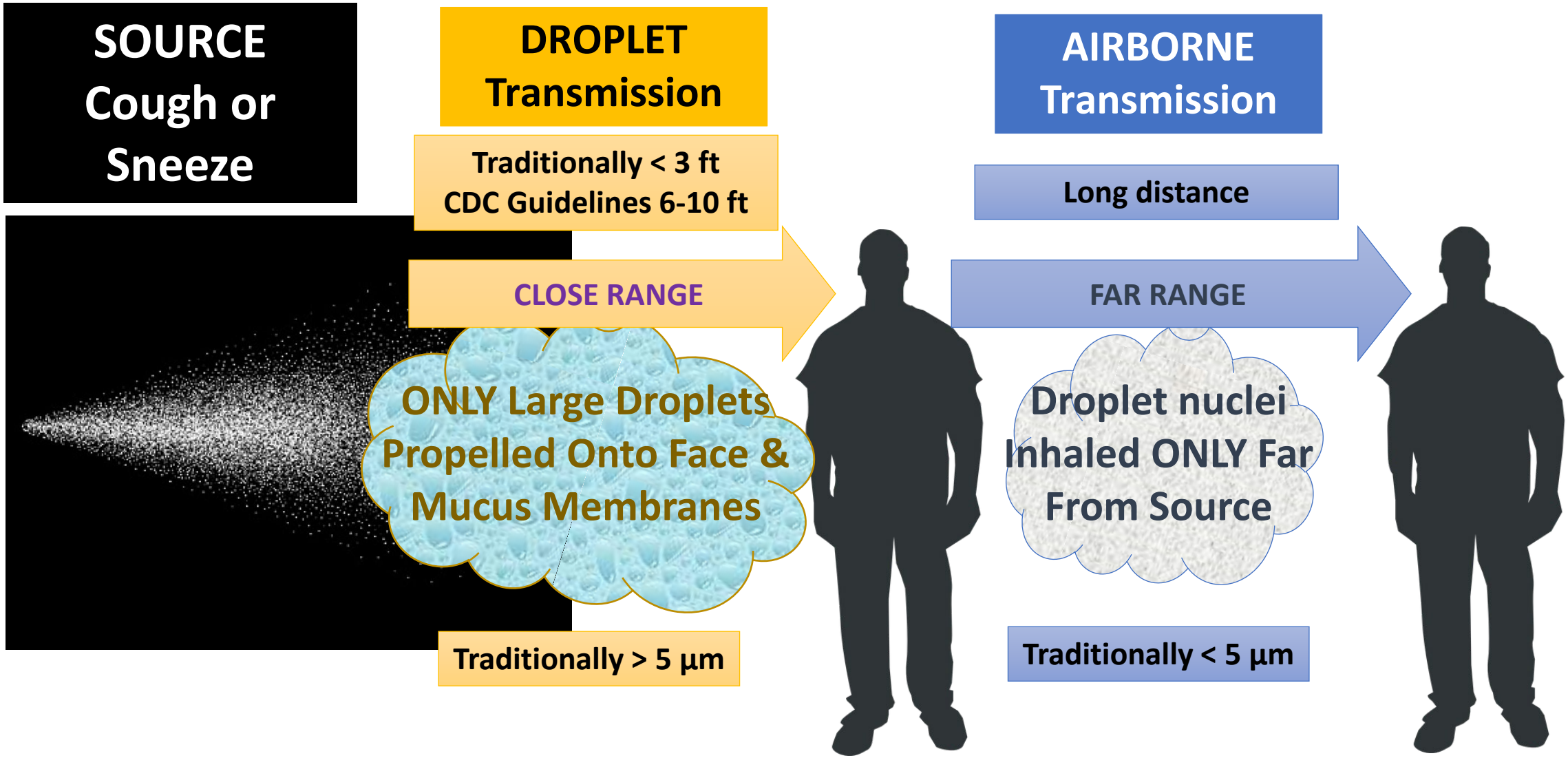
All Disease Transmission Routes are Possible for COVID-19

Contact	Transfer from infectious source or object to mucous membranes (usually by hands)
Droplet	Large droplets “**propelled**” onto face and mucous membranes (**no inhalation**)
Airborne	Droplet nuclei **inhaled** ONLY when susceptible person is far from infectious source
Aerosol	Aerosols inhaled near the source

Classic (Outdated)Disease Transmission Paradigm



AEROSOL GENERATION

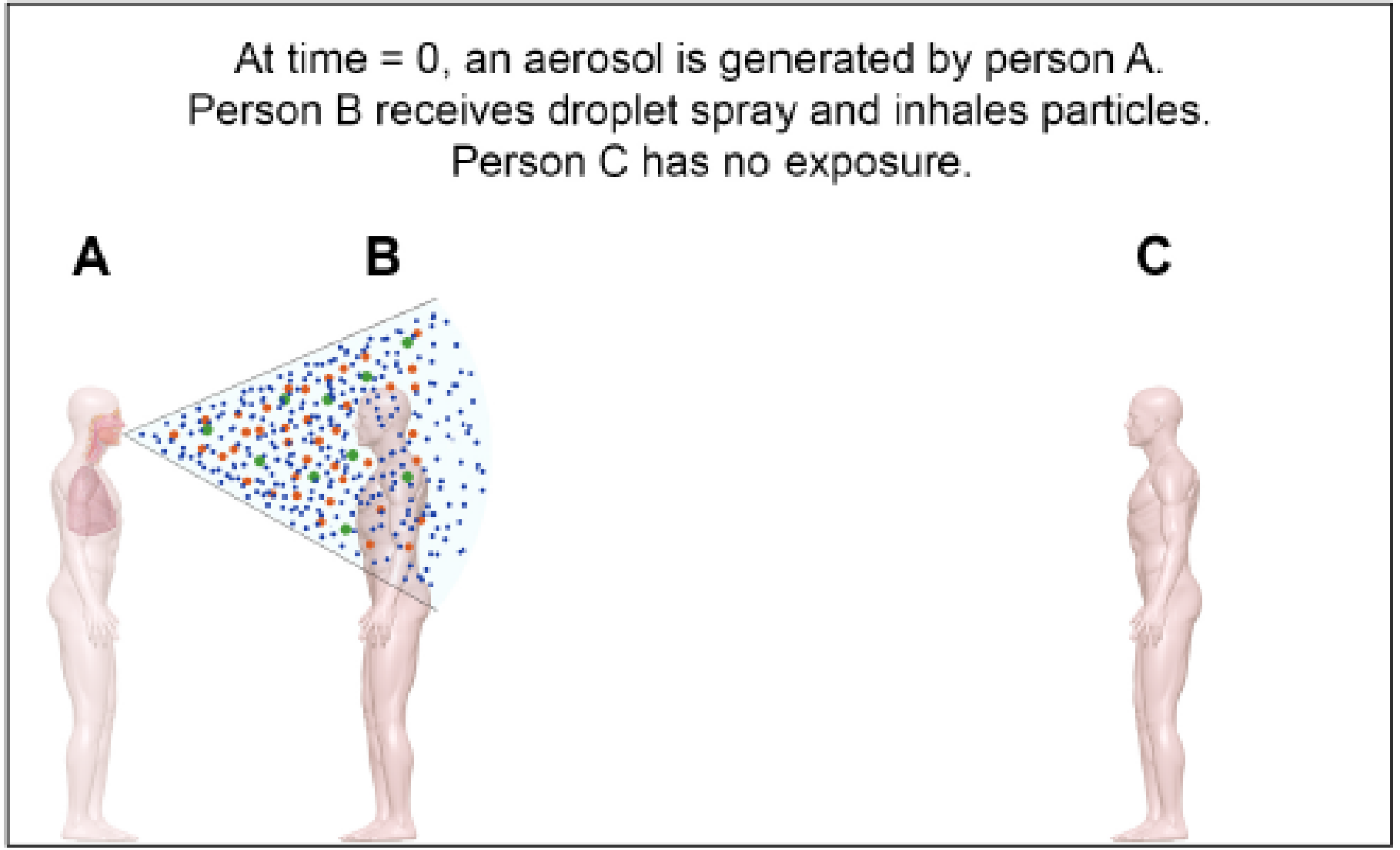
Aerosols can be generated by natural processes:

- Vomit
- Hemorrhage
- Diarrhea (toilet flushing)
- Coughing
- Sneezing
- Talking

Aerosols can be generated by medical procedures:

- Intubation
- Bronchoscopy
- Drug delivery
- Respiratory support

Inhalation can occur at the time and near the point of generation



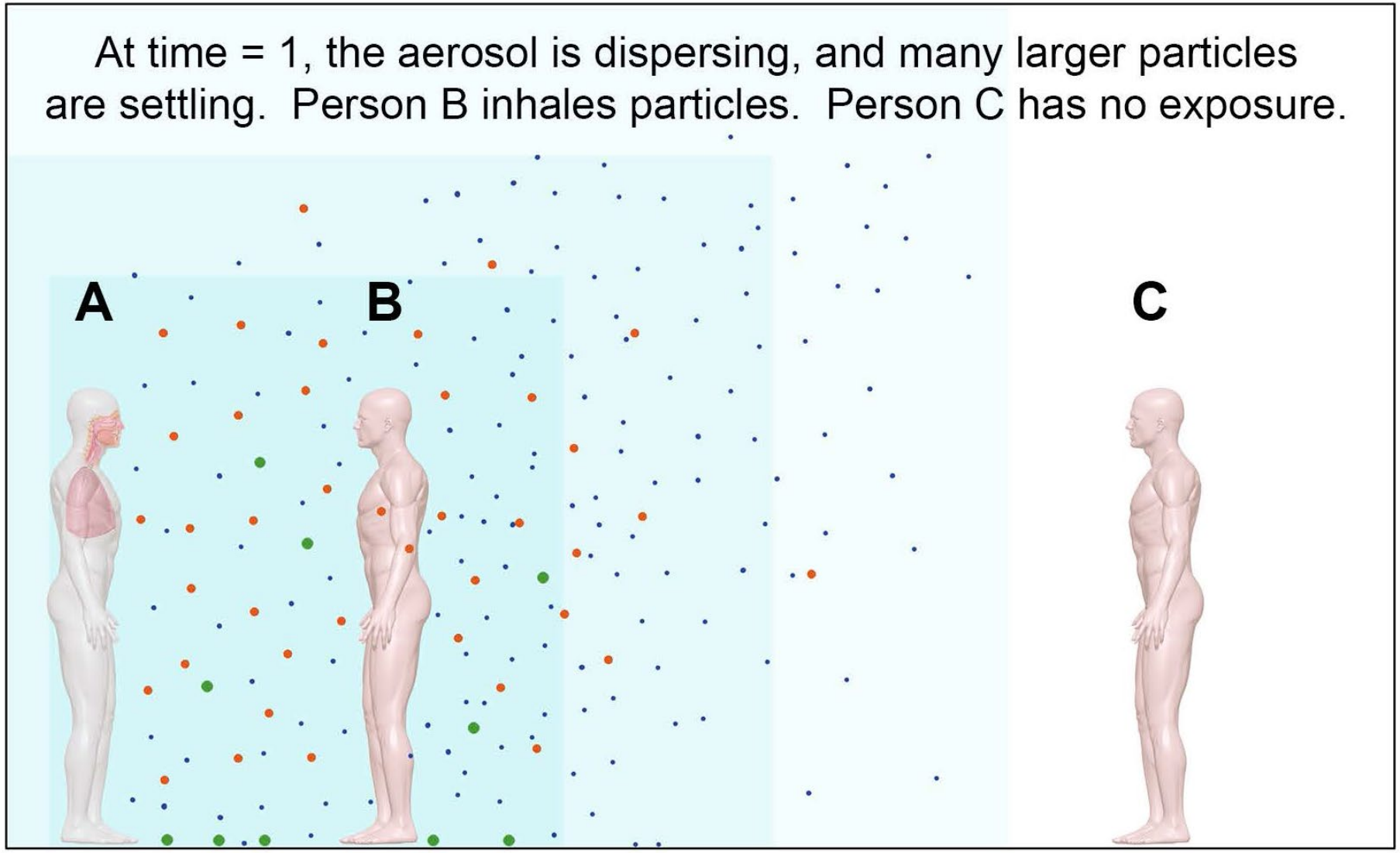
AEROSOL SETTLING AND DIFFUSION

Inhalation is possible near and further from the point of generation

Inhalation continues to be possible near the source as settling and diffusion take place.

Aerosol transmission (inhalation) is possible further from the source over time.

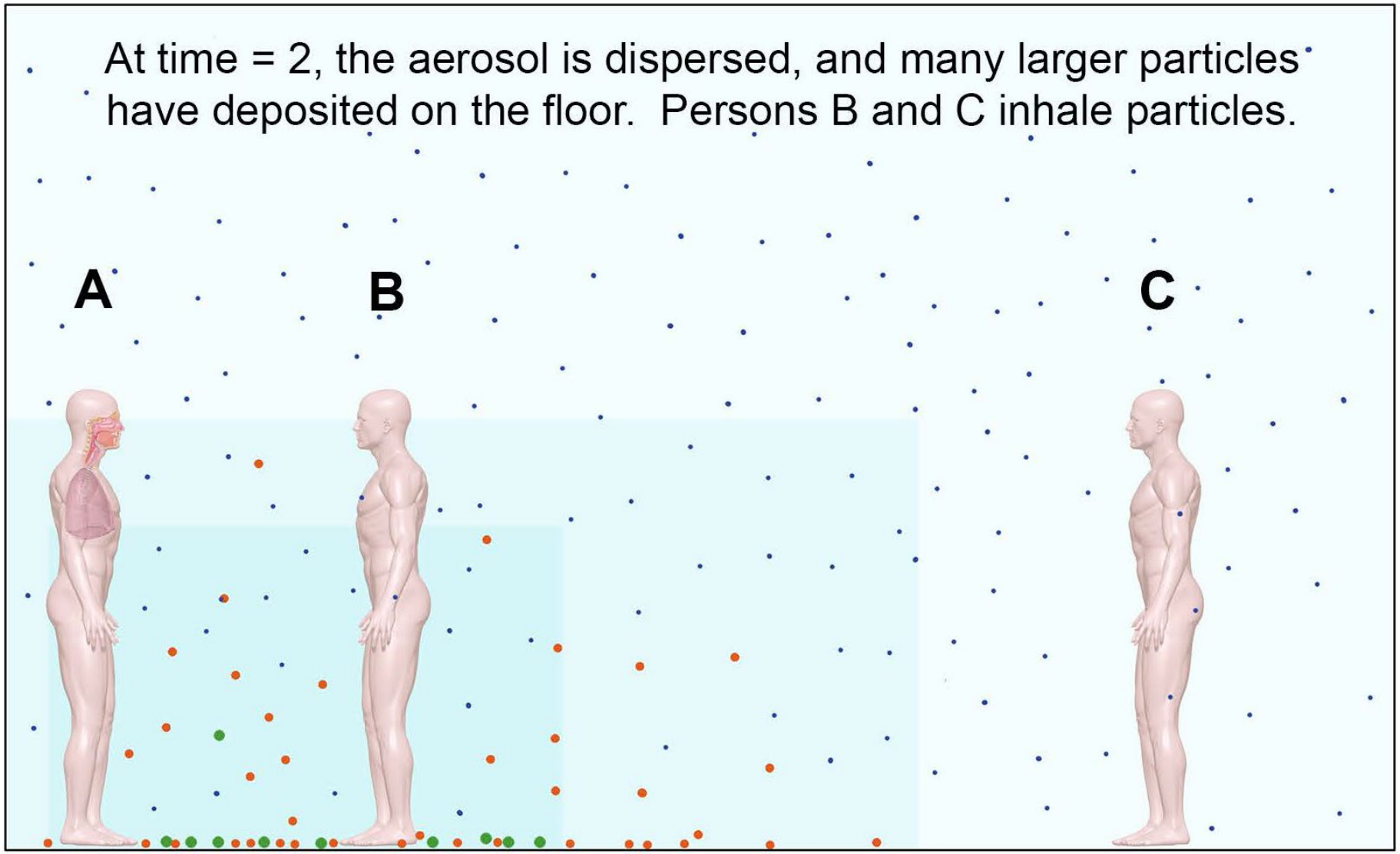
Infection depends on organism viability and dose (concentration of organisms in aerosol).



AEROSOL DIFFUSION AND SETTLING

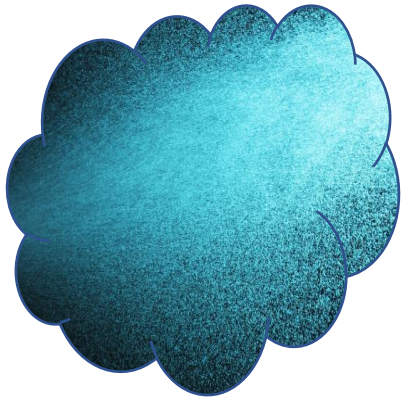
Aerosol transmission (inhalation) is possible throughout the space

Infection depends on organism viability and dose (concentration of organisms in aerosol).



New Infection Control Paradigm Includes Aerosol Transmission

Aerosol Contains Particles in Wide Range of Sizes



Sources:
Breathing, Talking, Coughing, Sneezing

AEROSOL Transmission

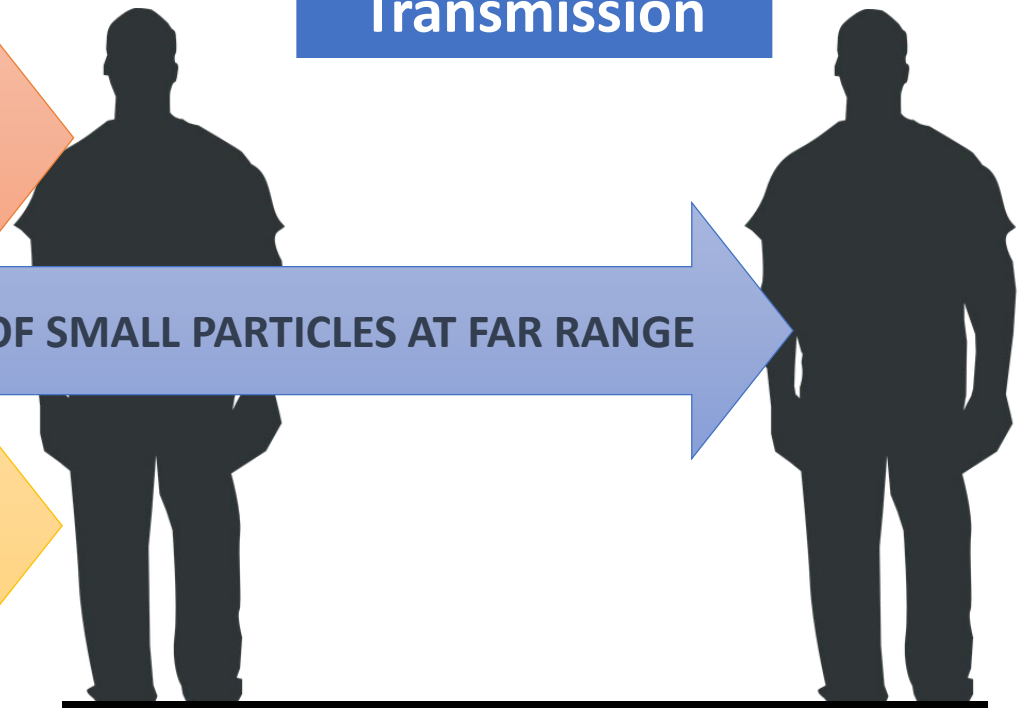
INHALATION OF SMALL PARTICLES AT CLOSE RANGE

AIRBORNE Transmission

INHALATION OF SMALL PARTICLES AT FAR RANGE

PROPULSION OF LARGE PARTICLES AT CLOSE RANGE

DROPLET Transmission



AN ORGANISM CAPABLE OF AIRBORNE TRANSMISSION IS ALSO AEROSOL TRANSMISSIBLE

Hierarchy of Controls

- Engineering Controls
  - Ventilation
  - Isolation
  - Filtration
- Administrative & Work Practice Controls
  - Communication
  - Restriction
  - Quarantine
  - Disinfection
  - Education
  - Medical Surveillance

All of these should be used to limit who is exposed and when and where exposures occur

Why Respirators for SARS-CoV-2 in Healthcare?

- Exposure near a source (infectious patient) not easy to control
- SARS-CoV-2 is an aerosol-transmissible high-risk virus [Risk Group 3]
  - No vaccine and few known treatments
  - Potentially serious health outcomes and mortality
- Anyone could be infected and infectious
- Potential for on-going infectious aerosol exposures in patient spaces

Negative Pressure Air Purifying Respirators

- Wearer does all the work of drawing air through a cleaning device into the facepiece
- Cleaning device must be specific to the contaminants
  - Aerosol = filter (N, P, R; 95, 99, 100)
  - Chemical = activated charcoal or other material

APF = 10

N95 filtering facepiece (disposable)

Half mask with replaceable N95 cartridges

OSHA APF = 50*

***If QNFT is conducted**

Full facepiece with replaceable cartridges

Filtering Facepiece Respirators in Healthcare

- Well-accepted in most US healthcare settings
- Supplies are not unlimited
- Re-use and extended use are possible
- Designed to be worn several times and then discarded
- Not designed to be cleaned or disinfected
- Do not fit well after 5-10 donnings

Elastomeric Respirators

- Higher initial cost $20-50 but $$ savings over time
- Easy to clean and maintain
- Easy to seal check – more consistent fit each donning
- Full-facepiece design offers eye protection & higher overall protection
- If every healthcare worker caring for patients had an elastomeric respirator, FFR supplies would be available for all other healthcare and essential workers

What About Exhalation Valves?

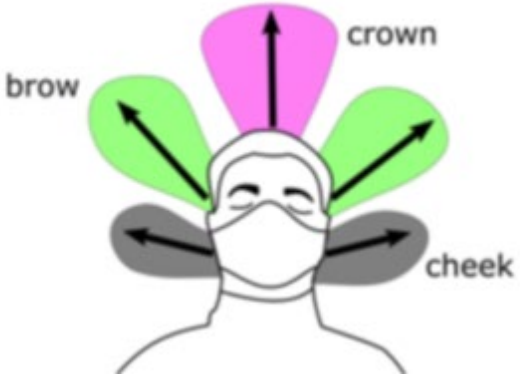
- No data!
- Not a problem if caring for COVID-19 patients
- Likely to be lower emissions from an exhalation valve than from a surgical mask or face covering

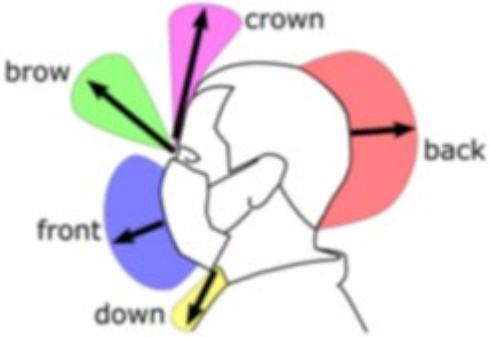
Exhaled particles follow a circuitous route

Seat

Valve

Cover





Air leaks from surgical masks and face coverings in all directions – including behind the head!

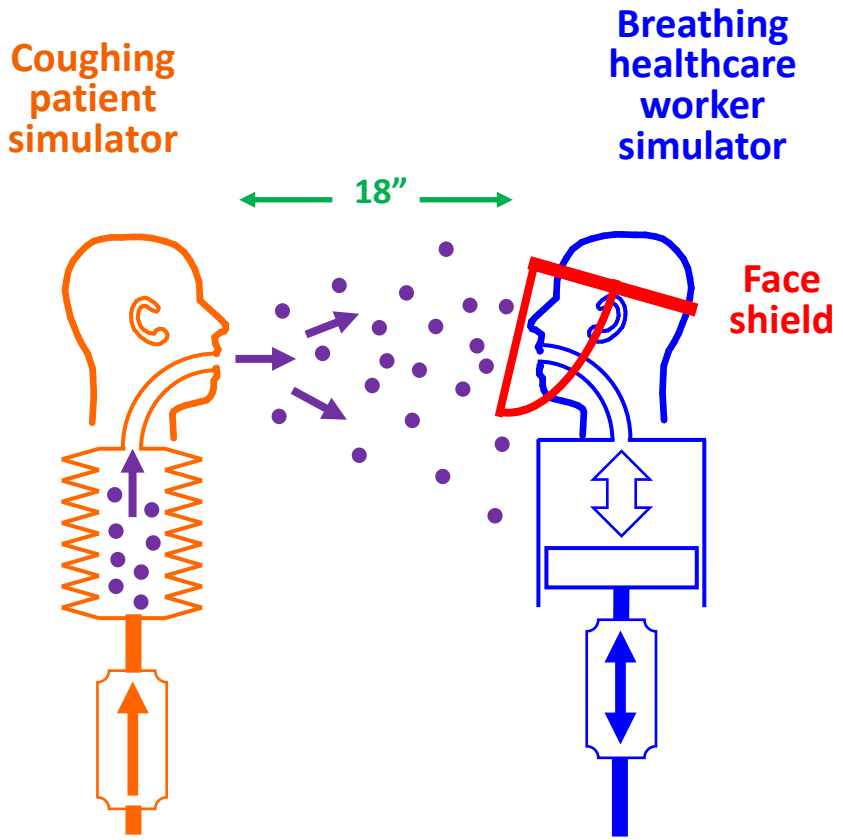
Viola, I. M., et al. "Face Coverings, Aerosol Dispersion and Mitigation of Virus Transmission Risk." arXiv preprint arXiv:2005.10720 (2020).

Important Issues & Solutions

- Filter cartridge changeout
  - Filter cartridges should last a long time (low particle concentrations)
  - Should probably change at least annually or when breathing resistance increases
- Communication with patients
  - Speaking diaphragm
- Eye protection
  - Face shields, goggles, safety glasses
  - Full-facepiece respirators (higher protection level)

Face Shields Reduce But Don't Eliminate Aerosol Inhalation

- Particles 0.1 to 100 µm coughed toward breathing simulator
- Face shield blocked 96% of aerosol from initial cough
- Smaller particles traveled around the faceshield & were inhaled
- Face shields a **useful supplement** to respiratory protection, but not a substitute



FROM: NIOSH N95 Day Webinar, William G. Lindsley, Healthcare Worker Exposure to Influenza Aerosols

Powered Air Purifying Respirators (PAPR)

OSHA APF = 25

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(1000 with studies)

- Air drawn through a cleaning device (filter) by pump into facepiece
- Less work of breathing than negative pressure respirators
- More comfortable, esp. if wearing lots of other PPE
- Higher protection than half-facepiece negative pressure respirators
- Studies demonstrate no release of particles from PAPRs