COVID-19 Routes of Transmission & Implications for Worker Protection

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Outline

- New Infection Control Paradigm
- Is COVID-19 Aerosol Transmissible?
- Protecting High Risk Workers
- All Modes of Transmission Are Possible for COVID-19

New Infection Control Paradigm

Classic Disease Transmission Paradigm

SOURCE
Cough or Sneeze

DROPLET Transmission

Traditionally < 3 ft
CDC Guidelines 6-10 ft

CLOSE RANGE

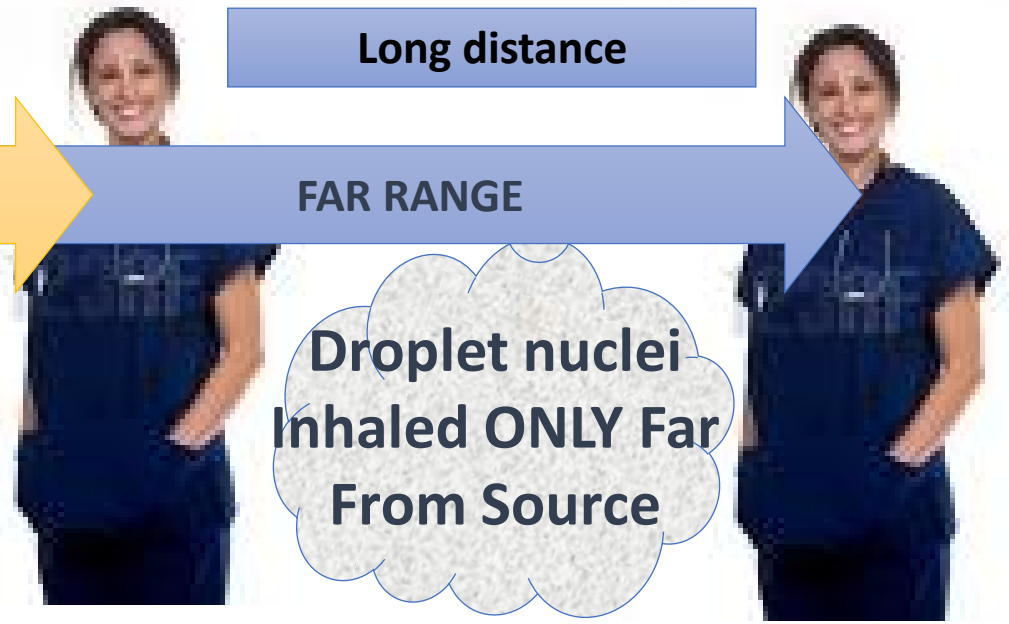
ONLY Large Droplets Propelled Onto Face & Mucus Membranes

Traditionally > 5 µm

AIRBORNE Transmission

Long distance

FAR RANGE



Droplet nuclei Inhaled ONLY Far From Source

Traditionally < 5 µm

AEROSOL GENERATION

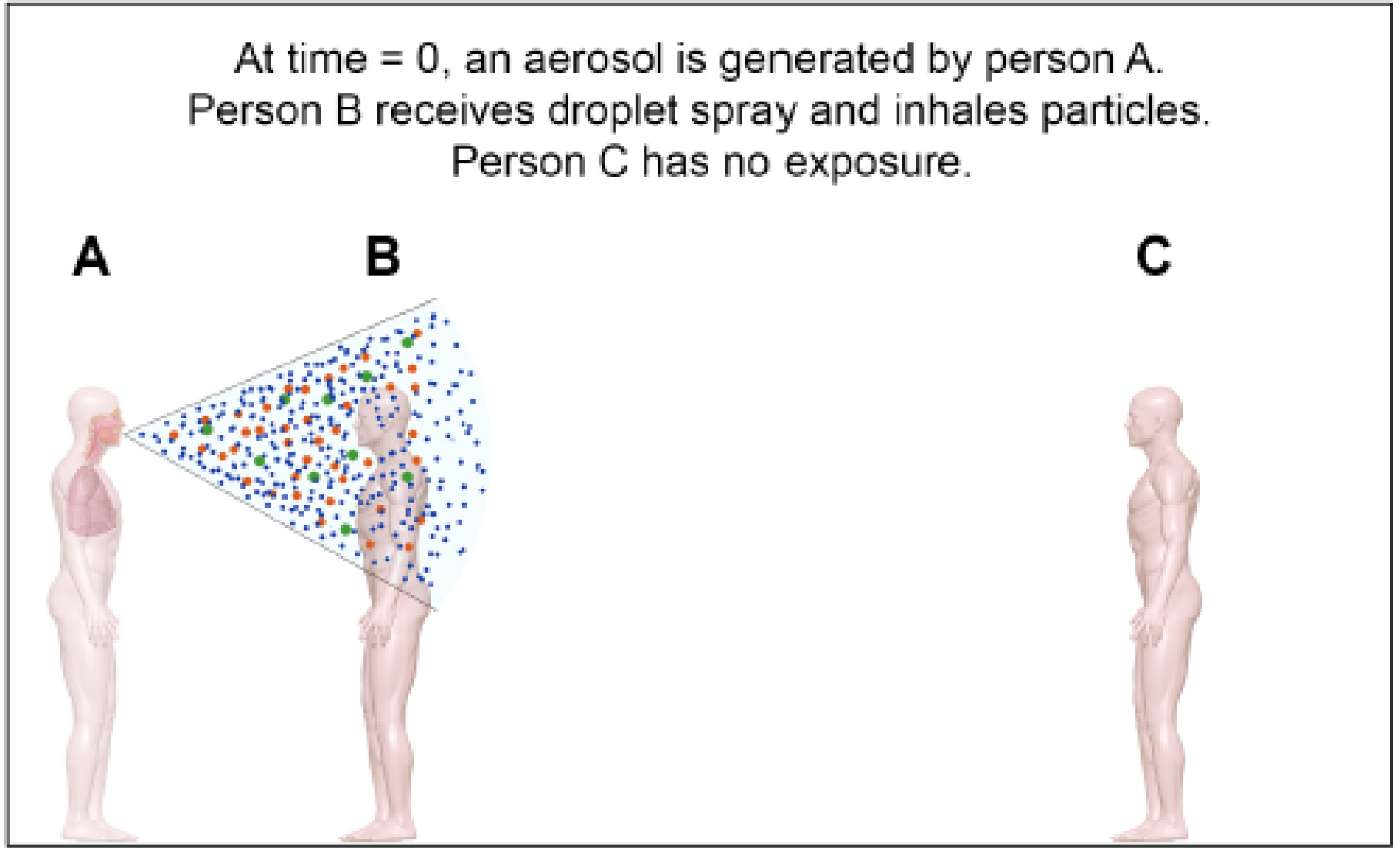
Aerosols can be generated by natural processes:

- 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



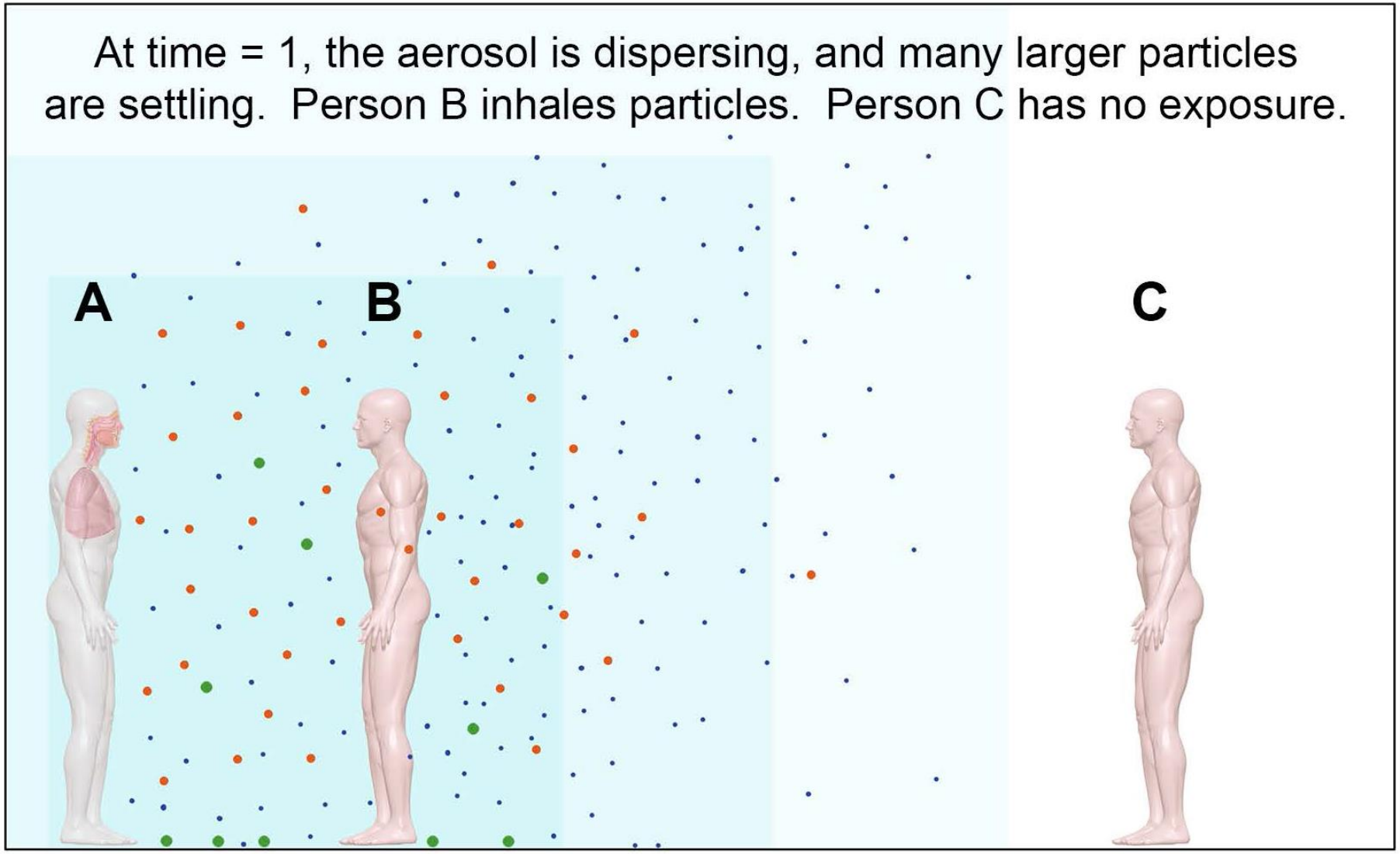
AEROSOL SETTLING AND DIFFUSION

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.

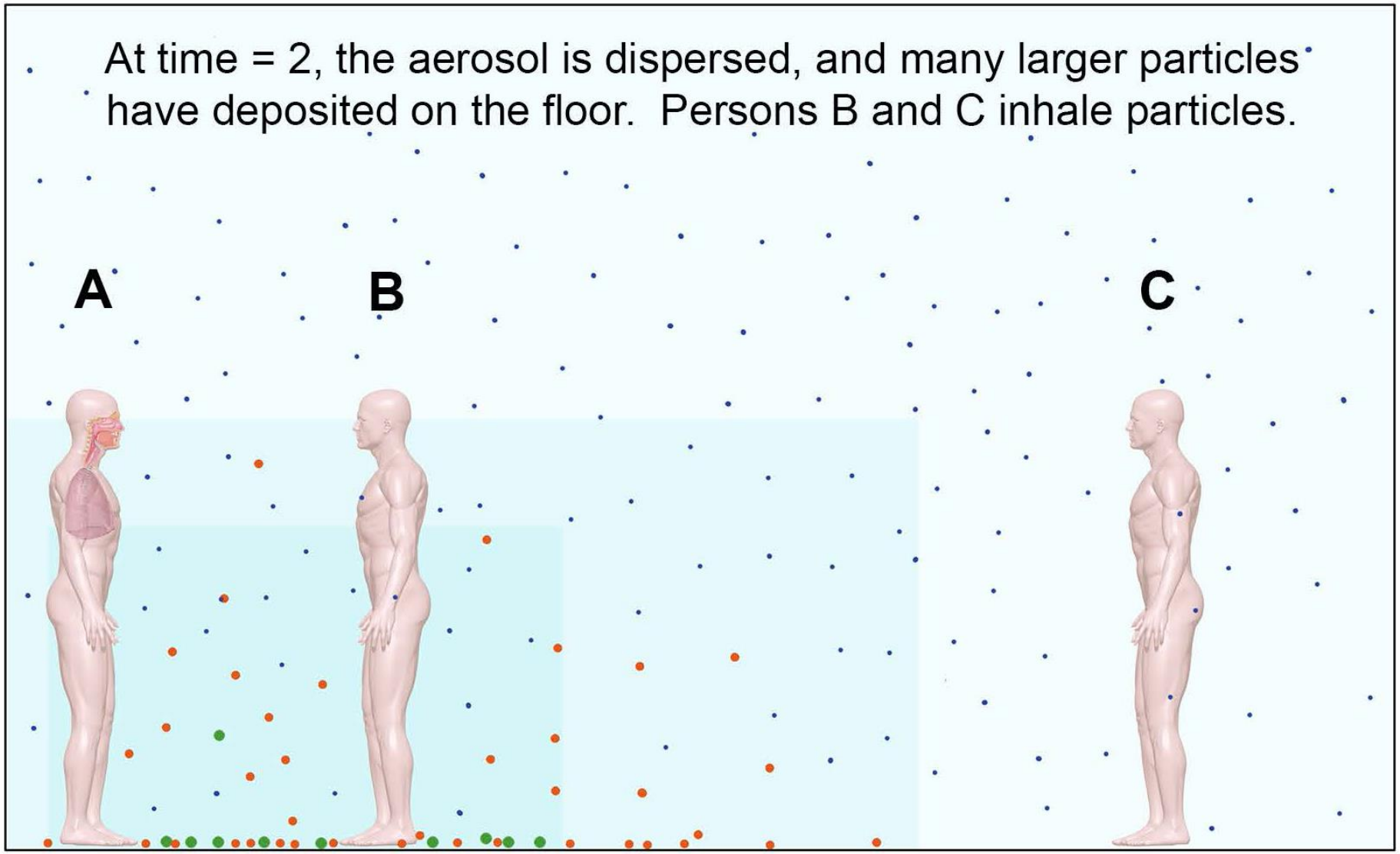
Infection depends on organism viability and dose (concentration of organisms in aerosol).



AEROSOL DIFFUSION AND SETTLING

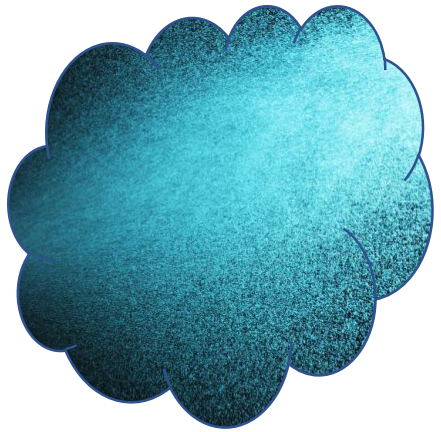
Aerosol transmission (inhalation) is possible throughout the space

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



We Need a New Infection Control Paradigm That Includes Aerosol Transmission

Aerosol Contains Particles in Wide Range of Sizes



Source Symptoms & Some Medical Procedures

AEROSOL Transmission

INHALATION OF SMALL PARTICLES AT CLOSE RANGE

PROPULSION OF LARGE PARTICLES AT CLOSE RANGE

DROPLET Transmission

INHALATION OF SMALL PARTICLES AT FAR RANGE

AIRBORNE Transmission

IF AN ORGANISM IS AIRBORNE IT IS ALSO AEROSOL TRANSMISSIBLE

Is COVID-19 Aerosol Transmissible?

Aerosol Transmission

Establish biological plausibility*

- Aerosols are generated at a source
- Organism remains viable in air at environmental conditions along a path
- Receptors are accessible following inhalation or impaction

- COVID-19 virus is present and viable in nasal & throat swabs and sputum samples before and as symptoms develop, through day 7
- By analogy to influenza, viable aerosols are possible (breathing, talking, coughing)
- By analogy to SARS and MERS, aerosols will be generated during medical procedures (intubation, bronchoscopy, etc.)

	Quality of Evidence		
Condition	**Weak (1)**	**Moderate (2)**	**Strong (3)**
Aerosol Generation	• Pathogen present in bodily fluids • Pathogen measured on surfaces in the area of infectious source	• Infection has symptoms or requires treatment that cause bodily fluids containing pathogens to be aerosolized • Pathogens are detected in aerosols emitted by infected animal models.	• Pathogens are detected in aerosols emitted by or generated from an infectious person

QUALITY OF EVIDENCE = MODERATE to STRONG (2-3)

- COVID-19 virus survives in the air for 3 hr
- A 3 µm particle can take up to 1 hr to settle in still air

Condition	Quality of Evidence		
	Weak (1)	**Moderate (2)**	**Strong (3)**
Viability in Environment	The pathogen, surrogate or laboratory-adapted strain using culture-based on culture-independent methods survives on surfaces at ambient conditions for hours	• The pathogen, using culture-independent methods, is present in the air at ambient conditions for hours in laboratory media or body fluids • Surrogate or laboratory-adapted strain, using culture-based methods survives in the air at ambient conditions for hours in laboratory media or body fluids	• The pathogen, using culture-based methods if available, survives in the air at ambient conditions for hours in laboratory media or body fluids • Epidemiologic evidence of transmission through air over long distances

QUALITY OF EVIDENCE = STRONG (3)

- By analogy to SARS and nature of disease, COVID-19 virus initiates infection in respiratory system. Not sure about other organs or tissues.
- COVID-19 is primarily a respiratory disease.

	Quality of Evidence		
Condition	**Weak (1)**	**Moderate (2)**	**Strong (3)**
Access to Target Tissue	Target tissue identified in animal models and is plausibly accessible to aerosols	• The target tissue has been identified through experimental infection in humans through non-aerosol routes or in vitro studies, and is plausibly accessible to aerosols • Experimental infection demonstrated in an animal model through the aerosol route.	• Experimental infection in humans has been demonstrated through the aerosol route

QUALITY OF EVIDENCE = MODERATE (2)

	Risk Group			
Weight of Evidence	1	2	3	4
9				
8		**Influenza**	**Tuberculosis**	
7		**Norovirus**	**SARS**	**Ebola**
6				
5				
4				
3				

COVID-19

Level of concern

Overall weight of evidence = 7 – 8 for COVID-19
Risk group = 3 (like SARS)
High level of concern for aerosol transmission
Explains rapid transmission from one person to the next

Jones RM and Brosseau LM. "Aerosol Transmission of Infectious Disease." *Journal of Occupational and Environmental Medicine* 57.5 (2015): 501-508.

Protecting High Risk Workers

	Risk Rank			
Exposure Rank	**R1**	**R2**	**R3**	**R4**
E1	A	A	B	B
E2	A	B	B	C
E3	B	B	C	C

Purpose: Save PPE for workers who most need it

Control Banding for Aerosol Transmissible Diseases*

* Sietsema, Margaret, et al. *Health security* 17.2 (2019): 124-132.

Band	Control Options
A	Source first Pathway second – generally prudent Receptor controls – generally not necessary
B	Source first – may require multiple options Pathway second – may require multiple options Receptor controls –if source and pathway are not effective
C	Source first – may require multiple options Pathway second – may require multiple options Receptor controls – generally prudent

Lower Exposure Level

Goal should be to reduce exposure to E1 levels, by selecting additional control strategies from the source and pathway categories and reducing reliance on PPE.

Airport Surveillance Worker During COVID-19 Pandemic

- Interacts with many people each workday
- Many may be infectious (even without fever or symptoms)
- Works 6 hr per day

Possible Likelihood of Exposure and Moderate Duration = Level of Exposure of E2

Control Band B
Requires Multiple Source and Path Controls

- Source Controls
  - Screen and exclude travelers with symptoms and other risk factors
- Effect of Source Controls
  - Interactions with people who are mostly healthy (lowers likelihood of exposure)
- Path Controls
  - May not be necessary
  - May need more source controls (e.g. travelers must demonstrate not infected with recent medical test)
  - May need path controls (e.g. physical separation of travelers and screeners)

	Risk Rank			
Exposure Rank	R1	R2	R3	R4
E1	A	A	B	B
E2	A	B	B	C
E3	B	B	C	C

Use Receptor Controls (e.g. PPE) only if all other controls have been implemented and are not effective

Masks and Respirators for COVID-19 Aerosols

Healthcare Workers Have Highest Risk

- Masks as source control on patients
- Airborne infection isolation rooms for suspected cases
- N95 filtering facepiece respirators for healthcare workers
- Respirators with higher levels of protection for patients with severe symptoms and aerosol-generating procedures

Workers with High Risk Not in Healthcare

- Implement as many source and path controls as possible before using PPE

Workers with Moderate or Low Risk

- Source and path controls
- No PPE

Public

- Stay home!
- No masks or respirators

All Disease Transmission Routes are Possible for COVID-19

Contact	Transfer from infectious source or object to mucous membranes
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