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Supplementary information

Transmissibility and transmission of respiratory viruses

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Supplementary Information

Transmissibility and transmission of respiratory viruses

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Supplementary Tables

Supplementary Table 1. Transmissibility, modes of transmission and transmission-based precautions of common respiratory viruses in humans (unabridged version).

Respiratory Virus	Human coronavirus (HCoV)	Influenza virus[a] (IV)	Measles (MeV)	Parainfluenza virus (PIV)	Respiratory syncytial virus (RSV)	Human metapneumovirus (HMPV)	Varicella zoster virus (VZV)	Rhinovirus (RhV)	Human bocavirus[b] (HBoV)	Human adenovirus[c] (HAdV)
<u>Virology</u>										
Family	*Coronaviridae*	*Orthomyxoviridae*	*Paramyxoviridae*		*Pneumoviridae*		*Herpes-viridae*	*Picorna-viridae*	*Parvo-viridae*	*Adeno-viridae*
Virion structure	Enveloped	Enveloped	Enveloped		Enveloped		Enveloped	Non-enveloped	Non-enveloped	Non-enveloped
Genomic structure	Positive-sense non-segmented ssRNA virus	Negative-sense segmented ssRNA virus	Negative-sense non-segmented ssRNA virus		Negative-sense non-segmented ssRNA virus		dsDNA virus	Positive-sense non-segmented ssRNA virus	ssDNA virus	dsDNA virus
Common respiratory viruses from the same family[d]	Coronaviruses, including (1) novel viruses at the start of a pandemic or emerging viruses such as SARS-CoV-2, SARS-CoV and MERS-CoV, and (2) circulating endemic viruses which cause common cold such as HCoV-OC43 (*Betacoronavirus 1*), HCoV-229E, HCoV-NL63 and HCoV-HKU1	Influenza viruses, including (1) novel viruses at the start of a pandemic such as the 1918 influenza A/H1N1 virus, 1957 influenza A/H2N2 virus, 1968 influenza A/H3N2 virus and 2009 influenza A/H1N1 virus, (2) circulating endemic viruses which cause seasonal influenza such as influenza A/H1N1 virus, influenza A/H3N2 virus and influenza B virus, and (3) zoonotic (avian) viruses such as influenza A/H5N1 virus and influenza A/H7N9 virus	Measles (*Measles morbillivirus*), parainfluenza viruses (including *Human respirovirus* & *Human orthorubulavirus*), and mumps (*Mumps orthorubulavirus*)		RSV (*Human orthopneumovirus*), and HMPV		VZV (*Human alphaherpes virus 3*)	Rhinovirus, enterovirus, poliovirus, and coxsackie-virus (*Entero-virus A/B/C*)	HBoV1 (*Primate bocaparvovi rus 1*), and parvovirus B19	HAdV-B (*Human mastadeno -virus B*), HAdV-C (*Human mastadeno -virus C*), and HAdV-E (*Human mastadeno -virus E*)

Supplementary Table 1 (continued).

Respiratory Virus	HCoV	IV	MeV	PIV	RSV	HMPV	VZV	RhV	HBoV	HAdV
Transmissibility[e]										
Basic reproduction number (R_0)	SARS-CoV-2: 1.1–6.5 [1-11] SARS-CoV: 0.9–3.0 [11, 12] MERS-CoV: 0.5–8.0 [11, 12] HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	Pandemic 1918 A/H1N1: 1.0–4.3 [13] Pandemic 1957 A/H2N2: 1.4–1.7 [13] Pandemic 1968 A/H3N2: 1.1–2.1 [13] Pandemic 2009 A/H1N1: 1.1–21.0 [13] Endemic A/H1N1: 1.2–21.0 [13] Endemic A/H3N2: 1.2–1.4 [13, 14] Endemic B: 1.1 [13] Zoonotic A/H5N1: <1.0–1.1 [13] Zoonotic A/H7N9: <0.1–0.5 [15-17]	1.4–770 [18]	2.3–2.7 [19]	0.9–21.9 [12, 19-25]	-	1.2–16.9 [26-30]	1.2–2.7 [12, 19]	-	2.3–5.1 [19, 31]
Household secondary attack rate (SAR; %)	SARS-CoV-2: 3.9–38.2 [32] SARS-CoV: 0–12.3 [32] MERS-CoV: 0–9.0 [32] HCoV-OC43: 10.6–13.2 [32] HCoV-229E: 7.2–14.9 [32] HCoV-NL63: 0–12.6 [32] HCoV-HKU1: 8.6 [32]	Pandemic 1918 A/H1N1: - Pandemic 1957 A/H2N2: 7.1–9.1 [33] Pandemic 1968 A/H3N2: 24.1 [34] Pandemic 2009 A/H1N1: 3.0–38.0 [35] Endemic A/H1N1: 17.0–33.0 [36, 37] Endemic A/H3N2: 5.7–28.0 [37-40] Endemic B: 10.5–33.0 [33, 34, 37, 38] Zoonotic A/H5N1: 5.5–29.0 [41, 42] Zoonotic A/H7N9: 1.4 [17]	52.0–84.6 [43-47]	36.0–67.0 [48, 49]	11.6–39.3 [48, 50, 51]	-	61.0–78.1 [46, 52, 53]	28.0–58.0 [54, 55]	-	-

Supplementary Table 1 (continued).

Respiratory Virus	HCoV	IV	MeV	PIV	RSV	HMPV	VZV	RhV	HBoV	HAdV
Evidence for individual modes of transmission[f]										
Direct contact										
Infectious virus survival on experimentally contaminated hands[g]	SARS-CoV-2: ✓ [56] SARS-CoV: - MERS-CoV: - HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	A/H1N1: ✓ [56-60] A/H3N2: ✓ [57] B: ✓ [60]	-	✓ [61, 62]	✓ [63]	-	✓ [64]	✓ [61, 62, 65-67]	-	-
Virus genetic materials recovered on naturally contaminated hands	-	A/H1N1: - A/H3N2: - B: -	-	-	-	-	✓ [68, 69]	✓ [70]	-	-
Infectious virus recovered on naturally contaminated hands	-	A/H1N1: - A/H3N2: - B: -	-	-	-	-	-	✓ [67, 71-73]	-	-
Transfer of virus genetic materials between hands experimentally	-	A/H1N1: ✓ [58] A/H3N2: - B: -	-	-	-	-	-	-	-	-
Transfer of infectious virus between hands experimentally	-	A/H1N1: - A/H3N2: - B: -	-	-	✓ [63]	-	-	✓ [61, 62, 66, 72]	-	-
Infection initiated via exposure to infectious virus on hands demonstrated in volunteer studies	-	-	-	-	-	-	-	✓ [67, 74]	-	-
Transmission of laboratory-confirmed infection via hands demonstrated in observational studies	SARS-CoV-2: ✓ [75, 76] SARS-CoV: ✓ [77, 78] MERS-CoV: - HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	A/H1N1: ✓ [79, 80] A/H3N2: - B: -	✓ [81]	-	✓ [82, 83]	-	-	-	-	✓ [84]
Transmission of laboratory-confirmed infection via hands demonstrated in volunteer studies	-	A: ✓ [85] A/H1N1: - A/H3N2: - B: ✓ [85]	-	-	-	-	-	✓ [72, 86, 87]	-	-

Supplementary Table 1 (continued).

Respiratory Virus	HCoV	IV	MeV	PIV	RSV	HMPV	VZV	RhV	HBoV	HAdV
Indirect contact (fomite)										
Infectious virus survival on experimentally contaminated surfaces[g]	SARS-CoV-2: ✓ [56, 88-91] SARS-CoV: ✓ [91-94] MERS-CoV: ✓ [92, 95] HCoV-OC43: ✓ [61, 92, 96] HCoV-229E: ✓ [61, 92, 94, 96-99] HCoV-NL63: - HCoV-HKU1: -	A/H1N1: ✓ [58, 60, 95, 100-104] A/H3N2: ✓ [104] B: ✓ [60, 61, 104]	-	✓ [61, 62, 105]	✓ [61, 63]	✓ [106]	✓ [64]	✓ [61, 67, 104, 105, 107-109]	-	✓ [99, 110]
Virus genetic materials recovered on naturally contaminated surfaces	SARS-CoV-2: ✓ [88, 111-117] SARS-CoV: ✓ [118-120] MERS-CoV: ✓ [121, 122] HCoV-OC43: ✓ [123, 124] HCoV-229E: ✓ [125] HCoV-NL63: - HCoV-HKU1: -	A: ✓ [123, 126] A/H1N1: ✓ [127] A/H3N2: ✓ [128] B: ✓ [126]	✓ [129]	✓ [130, 131]	-	-	✓ [68, 69]	✓ [70, 123, 132, 133]	-	✓ [123, 134, 135]
Infectious virus recovered on naturally contaminated surfaces	SARS-CoV-2: ✓ [116] SARS-CoV: - MERS-CoV: ✓ [121, 122] HCoV-OC43: - HCoV-229E: ✓ [125] HCoV-NL63: - HCoV-HKU1: -	A/H1N1: ✓ [127] A/H3N2: - B: -	-	-	-	-	-	✓ [72]	-	✓ [134]
Transfer of virus genetic materials between hands and surfaces experimentally	-	A/H1N1: ✓ [58] A/H3N2: - B: -	-	-	-	-	-	✓ [70]	-	-
Transfer of infectious virus between hands and surfaces experimentally	-	A/H1N1: ✓ [60, 61] A/H3N2: - B: -	-	✓ [61, 62]	✓ [61, 63]	-	-	✓ [61, 62, 66, 67, 73, 107, 108, 136]	-	✓ [137]
Infection initiated via exposure to infectious virus on surfaces demonstrated in volunteer studies	-	-	-	-	-	-	-	-	-	-
Transmission of laboratory-confirmed infection via surfaces demonstrated in observational studies	SARS-CoV-2: ✓ [138] SARS-CoV: ✓ [77, 139] MERS-CoV: - HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	-	-	-	-	-	✓ [140]	-	-	-
Transmission of laboratory-confirmed infection via surfaces demonstrated in volunteer studies	-	-	-	-	✓ [141]	-	-	✓ [136]	-	-

Supplementary Table 1 (continued).

Respiratory Virus	HCoV	IV	MeV	PIV	RSV	HMPV	VZV	RhV	HBoV	HAdV
Droplet[h]										
Infectious virus survival in experimentally generated droplets	-	A/H1N1: ✓ [142-144] A/H3N2: ✓ [142] B: ✓ [142]	-	(✓) [1–5 µm] [145]	-	-	-	-	-	-
Virus genetic materials recovered in droplets in human exhaled breath[i]	SARS-CoV-2: - SARS-CoV: - MERS-CoV: - HCoV-OC43: (✓) [>5 µm] [146] HCoV-229E: - HCoV-NL63: - HCoV-HKU1: (✓) [>5 µm] [146]	Untyped: (✓) [>7 µm] [147] A/H1N1: (✓) [>5 µm] [146, 148, 149] A/H3N2: (✓) [>5 µm] [146 150] B: (✓) [>5 µm] [146, 148, 150]	-	(✓) [>7 µm] [146, 147]	(✓) [>7 µm] [147]	(✓) [>5 µm] [146]	-	(✓) [>7 µm] [147]	-	-
Infectious virus recovered in droplets in human exhaled breath	-	A/H1N1: (✓) [>4 µm] [149] A/H3N2: - B: -	-	-	-	-	-	-	-	-
Virus genetic materials recovered in droplets in the air	SARS-CoV-2: (✓) [>4 µm] [111] SARS-CoV: - MERS-CoV: - HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	Untyped: (✓) [>4.7 µm] [151, 152] A: (✓) [>4 µm] [153-157] A/H1N1: (✓) [>4 µm] [127] A/H3N2: - B: (✓) [>4 µm] [154]	(✓) [>4.7 µm] [129]	-	(✓) [>4 µm] [156, 158, 159]	-	-	(✓) [>4 µm] [151, 154]	-	(✓) [>4 µm] [158, 160]
Infectious virus recovered in droplets in the air	-	-	-	-	(✓) [>7 µm] [161]	-	-	-	-	-
Infection initiated via exposure to infectious virus in droplets demonstrated in volunteer studies	SARS-CoV-2: - SARS-CoV: - MERS-CoV: - HCoV-OC43: - HCoV-229E: ✓ [162-164] HCoV-NL63: - HCoV-HKU1: -	A/H1N1: ✓ [165-167] A/H3N2: ✓ [168-173] B: ✓ [167]	-	-	✓ [163, 174-177]	✓ [178]	-	✓ [67, 72, 163, 179-183]	-	(✓) [15 µm] [183, 184]
Transmission of laboratory-confirmed infection via droplets demonstrated in observational studies	-	-	-	-	-	-	-	-	-	-
Transmission of laboratory-confirmed infection via droplets demonstrated in volunteer studies	-	-	-	-	-	-	-	-	-	-

Supplementary Table 1 (continued).

Respiratory Virus	HCoV	IV	MeV	PIV	RSV	HMPV	VZV	RhV	HBoV	HAdV
Aerosol[h]										
Infectious virus survival in experimentally generated aerosols	SARS-CoV-2: ✓ [91, 185-187] SARS-CoV: ✓ [91, 185] MERS-CoV: ✓ [95, 185] HCoV-OC43: - HCoV-229E: ✓ [188] HCoV-NL63: - HCoV-HKU1: -	A/H1N1: ✓ [95, 143, 144] A/H3N2: ✓ [142, 189] B: ✓ [142]	✓ [190]	✓ [145, 191]	✓ [192, 193]	-	-	-	-	✓ [191, 194]
Virus genetic materials recovered in aerosols in human exhaled breath[i]	SARS-CoV-2: - SARS-CoV: - MERS-CoV: - HCoV-OC43: ✓ [146] HCoV-229E: - HCoV-NL63: ✓ [146] HCoV-HKU1: ✓ [146]	A/H1N1: ✓ [146, 148, 149] A/H3N2: ✓ [146, 150] B: ✓ [146, 148, 150]	-	✓ [146, 147]	✓ [146]	✓ [146]	-	✓ [147]	-	-
Infectious virus recovered in aerosols in human exhaled breath	-	A/H1N1: ✓ [148] A/H3N2: ✓ [146, 150, 195] B: ✓ [146]	-	-	-	-	-	-	-	-
Virus genetic materials recovered in aerosols in the air	SARS-CoV-2: ✓ [111, 116, 196] SARS-CoV: - MERS-CoV: ✓ [122] HCoV-OC43: - HCoV-229E: ✓ [197] HCoV-NL63: - HCoV-HKU1: ✓ [197]	Untyped: ✓ [151, 152] A: ✓ [124, 153-157, 198, 199] A/H1N1: ✓ [127, 197] A/H3N2: ✓ [197, 198] B: ✓ [124, 153, 154, 197]	✓ [129]	✓ [197]	✓ [156, 158, 197, 200]	-	✓ [201]	✓ [151]	-	✓ [158, 160, 197, 199]
Infectious virus recovered in aerosols in the air	SARS-CoV-2: ✓ [116, 202] SARS-CoV: - MERS-CoV: ✓ [122] HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	A: ✓ [154] A/H1N1: ✓ [197] A/H3N2: ✓ [197] B: ✓ [154, 197]	-	-	✓ [161, 197]	-	-	-	-	-
Infection initiated via exposure to infectious virus in aerosols demonstrated in volunteer studies	-	A: ✓ [203] A/H1N1: ✓ [167] A/H3N2: - B: ✓ [167]	-	-	-	-	-	✓ [183]	-	✓ [183, 184, 204]
Transmission of laboratory-confirmed infection via aerosols demonstrated in observational studies	SARS-CoV-2: ✓ [205, 206] SARS-CoV: ✓ [207, 208] MERS-CoV: ✓ [209, 210] HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	A/H1N1: ✓ [80] A/H3N2: ✓ [211, 212] B: -	✓ [213, 214]	-	-	-	✓ [215-218]	-	-	-
Transmission of laboratory-confirmed infection via aerosols demonstrated in volunteer studies	-	-	✓ [219]	-	-	-	✓ [219]	✓ [71, 183]	-	-

Supplementary Table 1 (continued).

Respiratory Virus	HCoV	IV	MeV	PIV	RSV	HMPV	VZV	RhV	HBoV	HAdV
<u>Transmission-based precautions in healthcare settings[j]</u>										
Contact precautions	SARS-CoV-2: Y [220] SARS-CoV: Y [221] MERS-CoV: Y [222] HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	Pandemic influenza: N [221] Endemic influenza: N [221] Zoonotic influenza: Y [221]	N [221, 223]	Y [221]	Y [221]	Y [221]	N [221, 224]	Y [221]	-	Y [221]
Droplet precautions	SARS-CoV-2: Y [220] SARS-CoV: Y [221] MERS-CoV: Y [222] HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	Pandemic influenza: Y [221] Endemic influenza: Y [221] Zoonotic influenza: Y [221]	N [221, 223]	Y [221]	Y [221]	Y [221]	N [221, 224]	Y [221]	-	Y [221]
Airborne precautions	SARS-CoV-2: N [220] SARS-CoV: N [221] MERS-CoV: N [222] HCoV-OC43: - HCoV-229E: - HCoV-NL63: - HCoV-HKU1: -	Pandemic influenza: N [221] Endemic influenza: N [221] Zoonotic influenza: N [221]	Y [221, 223]	N [221]	N [221]	N [221]	Y [221, 224]	N [221]	-	N [221]

[a]Evidence on transmissibility and transmission-based precautions in healthcare settings is stratified by pandemic, endemic and zoonotic influenza viruses. Pandemic (influenza) virus refers to novel influenza virus that first appears in the population, whereas endemic (influenza) virus refers to influenza virus that has been circulating in the population. For example, influenza A/H1N1pdm09 virus circulated in 2009 is referred to as 'pandemic 2009 A/H1N1', while when circulated in later years (such as in 2011) it is referred to as 'endemic A/H1N1'. Zoonotic (influenza) virus refers to influenza virus that normally circulates in animals but occasionally causes infection in humans with limited human-to-human transmission. Evidence for individual modes of transmission is stratified by influenza virus types (influenza A virus or influenza B virus) and influenza A virus subtypes (influenza A/H1N1 virus or influenza A/H3N2 virus) where possible.

[b]There is a lack of evidence on all modes of transmission for human bocavirus.

[c]HAdV types that are considered mainly respiratory (but not enteric) are included.

[d]Species names of common respiratory viruses belonging to the same virus family are provided in parentheses.

[e]Range of reported estimates of the mean or median are provided. Estimates of household SAR in the absence of interventions were extracted where possible.

[f]Observational studies include epidemiological or outbreak investigations, whereas volunteer studies include challenge studies or randomized (controlled) trials.

[g]Data includes contamination by direct virus inoculation or contamination by volunteers who were experimentally infected.

[h]Particles with aerodynamic diameter larger than 5 µm are traditionally defined as droplets whereas those smaller are defined as aerosols. However, there is ongoing discussion on redefining the particle size threshold between droplets and aerosols (refer to the section 'Terminology and defining features of modes of transmission' in the main text). Therefore, for evidence on droplet transmission, evidence is provided in parentheses if evidence of virus recovery is only identified in particles with aerodynamic diameter between 5–100 µm. Air samples collected without size fractionation but were collected over 2 meters from a known source (for example, an infected individual) are considered as evidence suggestive of aerosols.

[i]Evidence for virus genetic materials recovered in droplets or aerosols in human exhaled breath for IV types/ subtypes, PIV, RSV and HMPV is based on the author's own additional data of the published study[146].

[j]Each precautions represents a set of infection prevention and control practices and personal protective equipment recommended by the WHO for healthcare workers during routine patient care (excluding aerosol-generating procedures) within healthcare facilities, with consideration of the current understanding on the modes of transmission of the respective pathogen. These transmission-based precautions are to be applied in addition to Standard precautions, which is always applied in all healthcare settings for all patients.

✓, evidence identified; (✓), evidence identified only in particles with aerodynamic diameter between 5–100 µm (applicable to droplet transmission only); -, evidence not found; Y, recommended; N, not recommended; HCoV, human coronavirus; IV, influenza virus; MeV, measles virus; PIV, parainfluenza virus; RSV, respiratory syncytial virus; HMPV, human metapneumovirus; VZV, varicella zoster virus; RhV, rhinovirus; HAdV, human adenovirus

Supplementary Table 2. Mechanistic evidence and effectiveness of common non-pharmaceutical interventions (unabridged version).

NPI		Targeted MoT[a]	Mechanism of action	Mechanistic evidence	Effectiveness[b]
PPE and hygienic practice	Hand hygiene	- Contact	- ***Soaps*** remove organic substances by detergent properties[225]. - ***Alcohol*** denatures proteins in the presence of water[225].	- ***Alcohol*** had higher viricidal activity on enveloped than non-enveloped viruses[225] e.g. inactivating coronaviruses in 30 seconds[226-228], although reduce viability by >1,000-fold on artificially inoculated hands when for adenovirus and rhinovirus [229]. - ***Alcohol-based hand sanitizers*** more efficacious than ***plain soaps*** on pathogen inactivation *in vivo*, although mostly based on evidence of bactericidal and less on viricidal activity[230].	- Multiple systematic reviews suggested ***hand hygiene*** alone significantly associated with reduced respiratory illness but not influenza virus infection in community settings[79, 231-233], perhaps due to insufficient compliance[234, 235]. - Studies on the effectiveness of ***hand hygiene*** on respiratory virus transmission in healthcare settings were not identified. - Insufficient studies to compare the efficacies of ***plain soaps*** versus ***alcohol-based hand sanitizers*** against respiratory infections[231, 233].
	Face coverings	- Droplet, Aerosol, (Contact)	- ***Face coverings as source control***: When worn by an infected individual, reduce virus release to the environment by ***filtration***[146] and immediate virus exposure of nearby healthy individuals by ***deflection***[236]. - ***Face coverings as protection***: When worn by a healthy individual, reduce exposure to virus-laden droplets and aerosols in the air. (- Might also reduce virus transfer for contact transmission by reducing the frequency of hands touching respiratory mucosa[237].)	- As ***source control***, ***surgical masks*** efficaciously reduced influenza virus and coronavirus release from patients by ***filtration***[146, 148]; efficacies on exhaled droplets and aerosols may vary between viruses[146]. Studies using mannequins suggested ***deflection*** also important in reducing virus release[236]. - As ***protection against close-range transmission***, ***cloth masks***[238], ***surgical masks***[239] ***and respirators***[240, 241] efficacious by filtration against artificial bacteriophage[238] or influenza aerosols[239-241] challenge. - As ***protection against long-range transmission***, in the absence of environmental air flow only 1% of radiolabeled saline aerosols generated from the source mannequin reached the exposed mannequin 3 feet apart, where only fitted ***respirators*** but not surgical masks reduced exposure to aerosols[236].	- Multiple systematic reviews of observational studies[242, 243] or randomized trials[243-245] mostly suggested the use of ***face coverings*** alone, or in combination with other NPIs, effective in reducing risk of respiratory illness or virus transmission in healthcare[242, 243] and high-risk community settings[245], while others do not[244]. - Low compliance to ***face shield*** during high-risk procedures associated with higher risk of respiratory illnesses in healthcare workers[246]. - ***Face mask*** use by household members before the primary case developed symptoms significantly associated with reduced SARS-CoV-2 household transmission in a retrospective cohort study[138].
Environmental disinfection and dilution	Surface cleaning	- Contact, (Droplet), (Aerosol)	- Common ***disinfectants used in healthcare settings*** include 0.1 mol/L sodium hydroxide, 70% ethanol, 70% 1-propanol, ethylene oxide and sodium hypochlorite[92, 247]. - Common ***household cleaning agents*** include liquid soap, 1% bleach, and antimicrobial or antiviral wipes[248, 249]. - Both disinfect contaminated surfaces by virus inactivation. (- Might also reduce droplet or aerosol transmission by reducing fomites available for resuspension during activities such as walking or door opening[250].)	- Common ***disinfectants used in healthcare settings*** effectively inactivated influenza virus[247] and coronaviruses[92] on surfaces within 1 minute in experimental settings. - Common ***household cleaning agents*** effectively inactivated (enveloped) influenza virus[248, 249], but less effective for (non-enveloped) adenovirus[249] in experimental settings. - ***Biweekly disinfection of toys*** significantly reduced adenovirus, rhinovirus and RSV, but not coronaviruses, parainfluenza virus and bocavirus, in the environment of daycare nurseries in a randomized trial[251].	- A systematic review found limited epidemiologic studies on effectiveness of ***surface and object cleaning*** in reducing community respiratory virus transmission during pandemics[232]. - ***Biweekly disinfection of toys*** in daycare nurseries did not reduce respiratory illness in a randomized trial[251]. - The combined use of ***alcohol-based hand sanitizer*** and ***chloride wipes***, compared to ***hand washing***, reduced gastrointestinal but not respiratory illness in elementary school students in a randomized trial[252]. - ***Daily household cleaning*** with disinfectants significantly associated with reduced household transmission of SARS-CoV-2[138].

Supplementary Table 2 (continued).

Environmental disinfection and dilution (cont'd)	**Air dilution by ventilation and directional airflow**	- Droplet, Aerosol	- ***Ventilation*** is the intentional introduction of outdoor air into a building, measured as ***ventilation rate*** as amount of outdoor air introduced per interior space volume (air changes per hour [ACH, h^{-1}]), or per occupant in the space (outdoor air rate per person [L s^{-1} $person^{-1}$]). ***Mechanical ventilation*** achieved via fans, ductwork or other Heating, Ventilation and Air-Conditioning (HVAC) systems; while ***natural ventilation*** achieved by manually opening windows or doors to allow indoor airflow via difference in wind and thermal pressure[253]. - ***Directional airflow*** provides clean air from the cleanest to less clean patient care areas, e.g. introducing air at the ceiling and exhausting near the floor, or via laminar airflow.	- Lower ***ventilation*** associated with rhinovirus RNA detection in the air in office environment in an observational study[254].	- Multiple systematic reviews suggested strong and sufficient evidence supporting the association between ***indoor ventilation*** and ***airflow patterns*** with transmission of SARS, influenza, measles and chickenpox[255, 256], although not yet validated by intervention studies or randomized trials[257]. - ***Directional airflow*** may reduce the risk of airborne infection in vulnerable patients or nosocomial transmission in healthcare settings[258, 259], and also in community settings e.g. aircraft cabins[260]. - Some hypothesized increasing indoor ***mechanical ventilation*** may be less effective or cost-effective to achieve sufficient risk reduction in crowded indoor areas given high level of exposure[261], or might increase aerosol dispersion and infection risk for individuals further away from the source[260]; ***directional airflow*** may therefore play a more important role than ventilation in reducing transmission[262].
	Air and surface disinfection by ultraviolet germicidal irradiation (UVGI)	- Aerosol, Contact	- ***UVGI*** is the use of UV light in the germicidal range (200–320 nm), especially UV-C (200–280 nm), for air and surface disinfection against bacteria[263] or viruses by nucleic acid cross-linking[264]. - ***Air disinfection***: in ***upper-room UVGI***, irradiation confined to room area above room occupants' heads to minimize direct exposure, but requires good vertical air movement in the room. In ***in-duct UVGI***, air passing through ventilation systems is irradiated inside the ducts inaccessible to occupants before recirculation or exhaustion[265]. - ***Surface disinfection***: UVGI used on internal surfaces of ventilation systems, or surfaces and equipment in healthcare settings[264], originally for bacterial decontamination[266] but may also be useful for viral decontamination.	- ***UV-C*** efficiently inactivated experimentally generated aerosols containing influenza virus[267] or coronaviruses[268], but less effective for adenovirus[194]. - At higher relative humidity, increased susceptibility to ***UV-C*** observed for experimentally generated aerosols containing adenovirus[194], but decreased for influenza virus[267] and vaccinia virus [269]. - A 5-minute exposure to ***UV-C*** efficiently inactivated experimentally generated MERS-CoV on glass slides by a million-fold reduction to undetectable level[270]. - ***Upper-room UVGI*** efficiently reduced infectious vaccina virus aerosols in a simulated hospital room[271]. - ***UVGI*** significantly inactivated experimentally inoculated influenza virus on respirators[272, 273].	- ***Upper-room UVGI*** was shown to prevent airborne transmission of measles in schools[219]. - ***Upper-room UVGI*** was associated with reduced influenza virus infections among tuberculosis patients[274]. - Randomized trials evaluating effectiveness of ***UVGI for air or surface disinfection*** in reducing respiratory virus transmission were not identified.

[a]Mode(s) of transmission listed in parentheses indicate possible but presumably less importance via that mode.
[b]Effectiveness on respiratory illness or virus transmission.
NPI, non-pharmaceutical intervention; MoT, mode of transmission; PPE, personal protective equipment; UV, ultraviolet; UVGI, ultraviolet germicidal irradiation

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