Appendix 2. Quanta Generation Rates for Aerosol Transmissible Diseases

Table summarizing reported quanta generation rates (q) and reproduction numbers (R0)

Disease	Agent	Quanta (h^{-1})	R0 (or Rt)	Location / Activity / Source	Reference
COVID-19	SARS-CoV-2 (Severe acute respiratory syndrome (SARS)	0.225	no data	Healthcare workers, COVID-19 patients	(Hota, Stein et al. 2020)
COVID-19	SARS-CoV-2	0.36	no data	Oral breathing light activity	(Buonanno, Morawska et al. 2020)
COVID-19	SARS-CoV-2	2.4	no data	Oral breathing heavy activity	(Buonanno, Morawska et al. 2020)
COVID-19	SARS-CoV-2	4.9	no data	Speaking light activity	(Buonanno, Morawska et al. 2020)
COVID-19	SARS-CoV-2	31	no data	Singing or speaking loudly light activity	(Buonanno, Morawska et al. 2020)
COVID-19	SARS-CoV-2	<1	no data	Low: person at rest	(Buonanno, Stabile et al. 2020)
COVID-19	SARS-CoV-2	>100	no data	High: person speaking and walking slowly	(Buonanno, Stabile et al. 2020)
COVID-19	SARS-CoV-2	14–48	no data	Estimated from rates of other airborne agents	(Dai and Zhao 2020)
COVID-19	SARS-CoV-2	no data	2.5	Current best estimate[a]	(CDC 2020)
COVID-19	SARS-CoV-2	no data	0.5[b] 0.41–0.62[c]	Guangzhou China, with isolation and quarantine	(Jing, Liu et al. 2020)

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[a] based on data received by CDC prior to April 29, 2020

[b] mean

[c] 95% confidence interval

Disease	Agent	Quanta (h^{-1})	R0 (or Rt)	Location / Activity / Source	Reference
COVID-19	SARS-CoV-2	no data	0.6[b] 0.49–0.74[c]	Guangzhou China, no isolation or quarantine	(Jing, Liu et al. 2020)
COVID-19	SARS-CoV-2	no data	1.4–2.5	Preliminary estimate	(International Health Regulations (2005) Emergency Committee 2020)
COVID-19	SARS-CoV-2	no data	2.2[b] 1.4–3.9[c]	First 425 confirmed cases in Wuhan up to January 4, 2020	(Li, Guan et al. 2020)
COVID-19	SARS-CoV-2	no data	2.2[d] 1.4–3.8[e]	Based on interval of 1,000–9,700 cases by January 18, 2020	(Riou and Althaus 2020)
COVID-19	SARS-CoV-2	no data	2.68[b] 2.47–2.86[f]	Wuhan to cities outside mainland China (December 31, 2019–January 28, 2020, 75,815 cases)	(Wu, Leung et al. 2020)
COVID-19	SARS-CoV-2	no data	3.38 ± 1.40[b] 1.90–6.49[g] 3.32[h] 2.81–3.82[c]	Summary of 62 reports	(Alimohamadi, Taghdir et al. 2020)
COVID-19	SARS-CoV-2	no data	4.7–6.6	New estimate (end of January 2020)	(Sanche, Lin et al. 2020)

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[d] median

[e] 90% high density interval

[f] 95% credible interval

[g] Range

[h] Pooled

Disease	Agent	Quanta (h^{-1})	R0 (or Rt)	Location / Activity / Source	Reference
COVID-19	SARS-CoV-2	no data	$3.8^b \pm 0.9$,	Diamond Princess cruise ship, before quarantine	(Azimi, Keshavarz et al. 2020)
COVID-19	SARS-CoV-2	no data	$0.1^b \pm 0.2$	Diamond Princess cruise ship, after quarantine	(Azimi, Keshavarz et al. 2020)
COVID-19	SARS-CoV-2	no data	$\leq 11^b$	Diamond Princess cruise ship	(Mizumoto and Chowell 2020)
COVID-19	SARS-CoV-2	no data	5.8^d $0.6–11.0^f$	Diamond Princess cruise ship, overall	(Mizumoto and Chowell 2020)
COVID-19	SARS-CoV-2	no data	6.1^d $0.5–11.8^f$	Diamond Princess cruise ship, passenger total	(Mizumoto and Chowell 2020)
COVID-19	SARS-CoV-2	no data	5.6^d $0.3–10.9^f$	Diamond Princess cruise ship, passenger to passenger	(Mizumoto and Chowell 2020)
COVID-19	SARS-CoV-2	no data	0.9 $0.3–1.5^f$	Diamond Princess cruise ship, crew total	(Mizumoto and Chowell 2020)
COVID-19	SARS-CoV-2	no data	0.5^d $0.3–0.8^f$	Diamond Princess cruise ship, crew to crew	(Mizumoto and Chowell 2020)
COVID-19	SARS-CoV-2	no data	0.5^d $0.2–0.8^f$	Diamond Princess cruise ship, crew to passenger	(Mizumoto and Chowell 2020)
COVID-19	SARS-CoV-2	no data	1000 IQR[i]: 680–1190	Skagit Valley Chorale weekly rehearsal	(Miller, Nazaroff et al. 2020)

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[i] IQR: Interquartile range

Disease	Agent	Quanta (h^{-1})	R0 (or Rt)	Location / Activity / Source	Reference
COVID-19	SARS-CoV-2	no data	Current state-specific estimate	Website providing up-to-date values for Rt (effective reproductive number) of COVID-19	(Systrom and Vladeck 2020)
SARS	SARS-related coronavirus	10–300	2–5	(Dai and Zhao 2020)	(Stephens 2012) (WHO 2003)
SARS	SARS-related coronavirus	GM[j] 28.94 GSD[k] 2.66	GM[j] 2.65 GSD[k] 2.55	Taiwan University Hospital	(Chen, Chang et al. 2006)
SARS	SARS-related coronavirus	100.8	no data	Aircraft	(You, Lin et al. 2019)
SARS	SARS-related coronavirus	GM[j] 28.77 GSD[k] 2.54	GM[j] 2.61 GSD[k] 2.61	Taiwan Hospital	(Liao, Chang et al. 2005)
SARS	SARS-related coronavirus	GM[j] 28.77 GSD[k] 2.54	GM[j] 0.77 GSD[k] 2.61	Elementary schools	(Liao, Chang et al. 2005)
Middle east respiratory syndrome (MERS)	MERS-related coronavirus	6–140	<1 1.0–5.7	(Dai and Zhao 2020)	(Stephens 2012) (WHO 2019)
Measles	Measles virus	570	no data	Average measles case	(Riley, Murphy et al. 1978)
Measles	Measles virus	5,580	no data	Measles outbreak in a school (index case)	(Riley, Murphy et al. 1978)
Measles	Measles virus	GM[j] 124.89 GSD[k] 1.51	GM[j] 17.6 GSD[k] 1.4	Airplane	(Chen, Chang et al. 2006)
Measles	Measles virus	570–56,000	11–18	(Dai and Zhao 2020)	(Stephens 2012) (Plans Rubio 2012)
Chickenpox	Varicella zoster virus	GM[j] 59.07 GSD[k] 1.99	GM[j] 9.25 GSD[k] 1.83	Airplane	(Chen, Chang et al. 2006)

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[j] GM: Geometric mean

[k] GSD: Geometric Standard Deviation

Disease	**Agent**	**Quanta (h^{-1})**	**R0 (or Rt)**	**Location / Activity / Source**	**Reference**
Chickenpox	Varicella zoster virus	no data	3.12–68.57	Belgium	(Effelterre, Shkedy et al. 2009)
Chickenpox	Varicella zoster virus	no data	5.3 CI[l] 3.5–10.5	England and Wales	(Farrington, Unkel et al. 2012)
Chickenpox	Varicella zoster virus	no data	10.9 CI[l] 5.7–33	Poland	(Farrington, Unkel et al. 2012)
Influenza	Influenza virus	15–50	1.6–3.0	(Dai and Zhao 2020)	(Stephens 2012) (Lee, Golinski et al. 2012)
Influenza	Influenza virus	79[m]	no data	Outdoor air exchange rate 0.1/h	(Rudnick and Milton 2003)
Influenza	Influenza virus	128	no data	Outdoor air exchange rate 0.5/h	(Rudnick and Milton 2003)
Influenza	Influenza virus	GM[j] 8.67 GSD[k] 1.52	GM[j] 10.65 GSD[k] 1.44	Airplane	(Chen, Chang et al. 2006)
Influenza	Influenza virus	GM[j] 66.91 GSD[k] 1.53	GM[j] 10.35 GSD[k] 1.48	Boeing aircraft (Rudnick and Milton 2003)	(Liao, Chang et al. 2005)
Influenza	Influenza virus	515 2,229.4 $TCID_{50}$[n]/h	no data	Air flight	(Sze To and Chao 2010) ex (Marsden 2003)
Common cold	Rhinovirus	1–10	no data	Experimental room	(Rudnick and Milton 2003)

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[l] CI: Confidence interval (95%)

[m] Using a steady-state equation underestimates *q* by a factor of 5 and 1.7 for outdoor air exchanges of 0.1 and 0.5/h, respectively.

[n] median tissue culture infectious dose

Disease	Agent	Quanta (h^{-1})	R0 (or Rt)	Location / Activity / Source	Reference
Tuberculosis (TB)	*Mycobacterium tuberculosis* bacteria	1.25	no data	Average TB patient	(Nardell, Keegan et al. 1991) ex (Riley, Mills et al. 1962)
Tuberculosis (TB)	*Mycobacterium tuberculosis* bacteria	12.7	no data	Outbreak in office building	(Nardell, Keegan et al. 1991)
Tuberculosis (TB)	*Mycobacterium tuberculosis* bacteria	60	no data	Laryngeal case of TB	(Nardell, Keegan et al. 1991) ex (Riley, Mills et al. 1962)
Tuberculosis (TB)	*Mycobacterium tuberculosis* bacteria	250	no data	Bronchoscopy-related outbreak	(Nardell, Keegan et al. 1991) ex (Catanzaro 1982)
Tuberculosis (TB)	*Mycobacterium tuberculosis* bacteria	360	no data	Bronchoscopy-related outbreak	(Gammaitoni and Nucci 1997) ex (Catanzaro 1982)
Tuberculosis (TB)	*Mycobacterium tuberculosis* bacteria	2,280	no data	Outbreak related to jet irrigation of abscess	(Gammaitoni and Nucci 1997) ex (Hutton, Stead et al. 1990)
Tuberculosis (TB)	*Mycobacterium tuberculosis* bacteria	5,400	no data	Autopsy outbreak	(Gammaitoni and Nucci 1997) ex (Kantor, Poblete et al. 1988)

Disease	Agent	Quanta (h^{-1})	R0 (or Rt)	Location / Activity / Source	Reference
Tuberculosis (TB)	*Mycobacterium tuberculosis* bacteria	30,840	no data	Intubation-related outbreak	(Gammaitoni and Nucci 1997) ex (Haley, McDonald et al. 1989)
Tuberculosis (TB)	*Mycobacterium tuberculosis* bacteria	1–50	2.22–5.46	(Dai and Zhao 2020)	(Stephens 2012) (Li, Pei et al. 2020)

How Aerosol Transmissible Diseases Are Defined

Division of Occupational Safety and Health, better known as Cal/OSHA, Title 8 Regulations
Subchapter 7. General Industry Safety Orders
Group 16. Control of Hazardous Substances
Article 109. Hazardous Substances and Processes

Department of Industrial Relations §5199. Aerosol Transmissible Diseases

Aerosol transmissible disease (ATD) or aerosol transmissible pathogen (ATP). A disease or pathogen for which droplet or airborne precautions are required, as listed in Appendix A.

Aerosol transmissible pathogen - laboratory (ATP-L). A pathogen that meets one of the following criteria: (1) the pathogen appears on the list in Appendix D, (2) the *Biosafety in Microbiological and Biomedical Laboratories* (BMBL) recommends biosafety level 3 or above for the pathogen, (3) the biological safety officer recommends biosafety level 3 or above for the pathogen, or (4) the pathogen is a novel or unknown pathogen.

Appendix A – Aerosol Transmissible Diseases/Pathogens (Mandatory)

This appendix contains a list of diseases and pathogens which are to be considered aerosol transmissible pathogens or diseases for the purpose of Section 5199. Employers are required to provide the protections required by Section 5199 according to whether the disease or pathogen requires airborne infection isolation or droplet precautions as indicated by the two lists below.

Diseases/Pathogens Requiring Airborne Infection Isolation

Aerosolizable spore-containing powder or other substance that can cause serious human disease, e.g. Anthrax/Bacillus anthracis

Avian influenza/Avian influenza A viruses (strains capable of causing serious disease in humans)

Varicella disease (chickenpox, shingles)/Varicella zoster and Herpes zoster viruses, disseminated disease in any patient. Localized disease in immunocompromised patient until disseminated infection ruled out

Measles (rubeola)/Measles virus

Monkeypox/Monkeypox virus

Novel or unknown pathogens

Severe acute respiratory syndrome (SARS)

Smallpox (variola)/Variola virus

Tuberculosis (TB)/*Mycobacterium tuberculosis*—Extrapulmonary, draining lesion; Pulmonary or laryngeal disease, confirmed; Pulmonary or laryngeal disease, suspected

Another disease for which public health guidelines recommend airborne infection isolation.

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