Table S1. Indices introduced in studied works

Indices	**Definition/Explanation**
Clean Air Delivery Rate (CADR)	$CADR = V(k_e - k_n - k_c)$Clean air delivery rate (CADR) in m^3/hr (ft^3/hr); V is the volume of the chamber in m^3 (ft^3); k_e is the total decay rate in h^{-1}, including both ventilation and cleaner; k_n is the natural decay rate, including only ventilation in h^{-1}; k_c is decay rate of the pollutant concentration, reflecting loss of pollutants due to deposition or adsorption in h^{-1} (Liang & Qin, 2017).
Mean age of air	The average time it takes for the inlet air to reach any point of the room. Calculated using tracer decay method. $\tau = \frac{1}{C_{a0}} \int_{t_0}^{\infty} C_a(t)dt$. Uniform concentration at time t_o is C_{a0}, the tracer C_{a0} is decaying replacing the supply air. τ is the time to clean any point in the room (W. M. Whyte et al., 2014).
SVE 3	Index carried out from Fourier series low-order-components for 3D concentration distribution, agreeing to normalized age of air and normalized pollutant concentration, when uniform source of contamination is assumed (Brouns, C.; Waters, 1991; Quarini et al., 1997).
Figures of merit	$FM1 = \left\lvert\frac{V_L - V_S}{V}\right\rvert$ where V is the entire volume of the room, V_S is the volume of the room containing fluid with an age greater than $\frac{t_o}{2}$, and V_L is the volume of the room containing fluid with an age more than $\frac{t_o}{2}$. $FM2 = \frac{1}{2}\frac{t_0}{t_m}$ where $t_m$is the average age of the fluid (Quarini et al., 1997).
Contamination removal effectiveness	$\varepsilon_c = \frac{C_e(t_\infty)}{C_m(t_\infty)}$ where, C_e = Contamination concentration at exhaust, C_m = mean concentration in the room and t_∞ = time required to obtain a stationary concentration (Lin, Hu, et al., 2010; Saidi et al., 2011).
Air Change Rate	$ACH = \frac{3600 q_0 C_0}{C_m V}$, where q_0 = airflow rate injected at pollutant source, C_0= contaminant concentration at the source, V is room volume (Lin, Hu, et al., 2010).
Final efficiency	$FE = \frac{C_0}{C_m}\frac{L}{SR}$, where C_0 – concentration at the outlet, C_m – mean concentration in the room, SR – spreading radius and L is the characteristic length making this index non-dimensional. SR = the first moment of the contaminant distribution function, may be calculated as $SR = \left[\frac{\int (X-X_0)^2\, CdV}{\int CdV}\right]^{0.5}$, where X_0 is the mass center of the concentration distribution function and is defined by $X_0 = \frac{\int XCdV}{\int CdV}$ (L. Zhou et al., 2017).
Efficiency Factor	The ratio of particle concentration in return air and average particle concentration in the room (Ljungqvist & Reinmuller, 1996).
Minimum air change rate	$n = \frac{(G-D)}{\{C_s[\varepsilon_v - \varepsilon_v r(1-\eta_r)] - (1-r)(1-\eta_n)\}}$ where n is the air change rate (h^{-1}), G is the rate of impurity emission in space averaged throughout the space (count/m^3/h), D is the rate of impurity deposition from air to surface in space averaged throughout the space, r is the ratio of recirculating air volume to supply air volume, C_s is the calculated impurity particle concentration at any time in space (count/m^3), η_n and η_r are the total filtration efficiency of outdoor air and recirculating air, finally ε_v is the ratio of particle concentration in return and exhaust air to average particle concentration in room (L. Zhou, Yao, et al., 2020).
Pump demand capacity (P_m^D) & differential pressure setpoint for the chilled water secondary and tertiary pump (P_d)	$P_d = \frac{h_t}{10.33} \times \left(1 + \frac{RM}{100}\right)$ and $p_m^d = 9.81 \times \frac{h_t \times \dot{Q} \times r}{\eta}$ where the total head loss, h_t, is equal to $h_t = h_s + h_m$, main head loss for straight pipe (m), h_s, could be calculated by $h_s = \sum_{i=1}^{n} 10.67 \times L_i \times Q_i^{1.85} \times C_i^{-1.85} \times D_i^{-4.87}$, and h_m, minor head loss for pipe fittings and valves, is $h_m = \sum_{i=1}^{m} 0.5165 \times \frac{KL_i \times V^2}{g}$, finally volumetric flow rate for the ith straight pipe (m^3/s), can be calculated by $Q_i = \frac{V \times D_i^2}{k \times 6 \times 10^9}$. In these sets of equations n is the number of straight pipes in the chilled network, L_i is the length of the ith straight pipe (m), D_i is the inside diameter of the ith straight pipe (m), C_i is the roughness coefficient for the interior of the ith straight pipe, V is the flow velocity (m/s), k is the transformation coefficient, m is the number of pipe fittings and valves in the chilled network, g is the gravity acceleration of fluid, KL_i is the roughness coefficient for the ith pipe fitting or valve, $\dot{Q}$ is the volumetric flow rate in pipes beginning at the pump (m^3/s), r is the specific gravity of water, and finally η is the total pump efficiency

Table S2. ACH Data retrieved from literature to produce Figure 3

Reference	ACH (or average inlet air velocity)	Data Source	Reference	ACH (or average inlet air velocity)	Data Source
(West, 1924)	20 to 60	Review	(Bugaj & Przydrozny, 1986)	21.5	Experimental
(Yaglou et al., 1930)	25	Experimental	(Woods et al., 1986)	25	Experimental
(Zappfe, 1932)	12	Standard	(Murray et al., 1988)	15	Experimental
(Watt, 1933)	3	Opinion	(Sadjadi & Liu, 1991)	(0.46 m/s to 0.41m/s)	Experimental
(ASHVE Guide, 1943)	8 to 15	Standard	(Maxwell et al., 1994)	(0.30-0.33 m/s)	Numerical
(Blowers & Crew, 1960)	17	Experimental	(Campbell, 1996)	240 to 300	Opinion
(GAULIN, 1963)	12	Book	(Nam, 2000)	41.9	Numerical
(T.W. Keithley, W.B. Cowan, 1963)	10 to 30	Experimental	(Rui et al., 2008)	(0.25 m/s)	Numerical
(GREENBERG, 1963)	18 to 30	opinion	(Lin, Tung, et al., 2010b)	70 to 139	Experimental
(Goddard, 1966)	6 to 12	Opinion	(Y. Wang et al., 2015)	50	Experimental
(Fox, 1969)	10 to 20	experimental	(C. Yang et al., 2015)	360	Numerical
(Baird, 1969)	7	opinion	(C. Yang et al., 2015)	288	Numerical
(Clark et al., 1974)	30	Experimental	(Rotheudt et al., 2017)	(0.25 m/s)	Numerical
(Whitcher et al., 1975)	25	Experimental	(Khankari, 2017)	37.5 ACH for the room and 150 ACH for the mini environment	Numerical
(Foord & Lidwell, 1975)	6	Experimental	(Loomans et al., 2019)	6	Numerical
(Manzo, 1977)	25	Review	(Loomans et al., 2020)	4	Experimental
(Criddle, 1978)	30	Experimental	(F. Y. Zhao et al., 2020)	16-22-30	Numerical
(Kundsin et al., 1979)	340 to 360 & 34 to 43 ACH	Experimental	(L. Zhou, Sun, et al., 2020)	40 to 120	Numerical
(Siskin, 1983)	12	Numerical	(Behrens et al., 2021)	10	Experimental
(Bugaj & Przydrozny, 1986)	20	Experimental	(Chen et al., 2022)	15 to 25	Numerical

REFERENCES

Baird, G. (1969). Air change and air transfer in a hospital ward unit. Build. Sci. 3, 113–124. https://doi.org/10.1016/0007-3628(69)90024-3

Behrens, D., Schaefer, J., Keck, C.M., Runkel, F.E. (2021). Effects of different air change rates on cleanroom 'in operation' status. Drug Dev. Ind. Pharm. 47, 1643–1655. https://doi.org/10.1080/03639045.2022.2043352

Blowers, R., Crew, B. (1960). Ventilation of operating-theatres. J. Hyg. 58, 427–448. https://doi.org/10.1017/S0022172400038572

Brouns, C., Waters, B. (1991). A guide to contaminant removal effectiveness. Technical Note AIVC 28-2, Air Infiltration and Ventilation Centre, Coventry.

Bugaj, A.H., Przydrozny, S. (1986). New Concept in Clean Room Techniques. Chem. Eng. Monogr. 24, 489–496.

Campbell, J. (1996). Semiconductor secondary gas panel enclosures: an overview of good ventilation design principles. Environmental and Occupational Risk Management - Compliance Engineering, Vol. 13, p. 5.

Chen, L., Wang, E., Li, Y., Weng, M., Liu, F. (2022). Study on self-cleaning time and suspended particle distribution in medical clean room. J. Phys. Conf. Ser. 2148, 012042. https://doi.org/10.1088/1742-6596/2148/1/012042

Clark, R.P., Baker, C.R., Glover, D.D. (1974). Room ventilation by natural convective air flows. Eng. Med. 3, 17–19. https://doi.org/10.1243/EMED_JOUR_1974_003_006_02

Criddle, E. (1978). Development of Clean Air Barriers for Operating Rooms. International Symposium on Contamination Control, 4th, Proc, 1–11.

Foord, N., Lidwell, O. M. (1975). Airborne infection in a fully air-conditioned hospital. Journal of Hygiene, 75(1), 15–30. https://doi.org/10.1017/S0022172400047033

Fox, D. G. (1969). A study of the application of laminar flow ventilation to operating rooms. Public Health Monograph, 78, 1–50.

GAULIN, R. P. (1963). How to keep infection out of the air. Modern Hospital, 100, 93–98.

Goddard, K. R. (1966). Hospital ventilation system design. ASHRAE, 46–49.

GREENBERG, A. (1963). Hospital air conditioning must be flexible. Modern Hospital, 100, 103–107.

Khankari, K. (2017). Air change rate analysis for a minienvironment cleanroom. ASHRAE J. 57, 38–46.

Kundsin, R.B., Bodman, H.A., Rappeport, J.M. (1979). Clean room and laminar flow room microbiology in the treatment of bone marrow transplant patients. J. Environ. Sci. 22, 27–29.

Liang, W., Qin, M. (2017). A simulation study of ventilation and indoor gaseous pollutant transport under different window/door opening behaviors. Build. Simul. 10, 395–405. https://doi.org/10.1007/s12273-016-0338-8

Lin, T., Hu, S.C., Chang, A., Lin, C.Y. (2010a). An innovative ventilation system for cleanrooms with high cooling loads. ASHRAE Trans. 116, 293–297.

Lin, T., Tung, Y.C., Hu, S.C., Lin, C.Y. (2010b). Effects of the removal of 0.1 μm particles in industrial cleanrooms with a Fan Dry Coil Unit (FDCU) return system. Aerosol Air Qual. Res. 10, 571–580. https://doi.org/10.4209/aaqr.2010.03.0014

Ljungqvist, B., Reinmuller, B. (1996). Clean Room Design: Minimizing Contamination Through Proper Design. CRC Press.

Loomans, M.G.L.C., Molenaar, P.C.A., Kort, H.S.M., Joosten, P.H.J. (2019). Energy demand reduction in pharmaceutical cleanrooms through optimization of ventilation. Energy Build. 202, 109346. https://doi.org/10.1016/j.enbuild.2019.109346

Loomans, M.G.L.C., Ludlage, T.B.J., Van Den Oever, H., Molenaar, P.C.A., Kort, H.S.M., Joosten, P.H.J. (2020). Experimental investigation into cleanroom contamination build-up when applying reduced ventilation and pressure hierarchy conditions as part of demand controlled filtration. Build. Environ. 176, 106861. https://doi.org/10.1016/j.buildenv.2020.106861

Manzo, J. P. (1977). RETROFITTING HOSPITAL AIR CONDITIONING SYSTEMS. Specifying Engineer.

Maxwell, G., Yamamoto, T., Gerbig, F. (1994). Optimum Airflow Velocity in Cleanrooms: Final Report Sponsored by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, RP-652.

Murray, W., Streifel, A., O'Dea, T., Rhame, F. (1988). Ventilation for protection of immune compromised patients. ASHRAE Trans. 94, 1185–1192.

Nam, S. (2000). Numerical simulation of smoke movement in clean room environments. Fire Saf. J. 34, 169–189. https://doi.org/10.1016/S0379-7112(99)00053-3

Quarini, G.L., Chang, Y.C., Tierney, M.J., Poulter, R. (1997). Characteristics and "figures of merit" for the value of the ventilation in clean rooms. Chem. Eng. Res. Des. 75, 672–676. https://doi.org/10.1205/026387697524317

Rotheudt, H., Hofer, V., Zielke, B., Schulze, D., Brockmann, G., Kriegel, M. (2017). Influences on flow separation at the wall in rooms with vertical unidirectional ventilation systems. Healthy Buildings Europe 2017.

Rui, Z., Guangbei, T., Jihong, L. (2008). Study on biological contaminant control strategies under different ventilation

models in hospital operating room. Build. Environ. 43, 793–803. https://doi.org/10.1016/j.buildenv.2007.01.018
Sadjadi, R., Liu, B. (1991). Supply plenum and airflow uniformity in cleanrooms. J. IES 34, 56–60. https://doi.org/10.17764/jiet.2.34.2.5r1742j3vg73n731
Saidi, M.H., Sajadi, B., Molaeimanesh, G.R. (2011). The effect of source motion on contaminant distribution in the cleanrooms. Energy Build. 43, 966–970. https://doi.org/10.1016/j.enbuild.2010.12.021
Siskin, M. (1983). Potential of building automation system towards efficient energy management of healthcare buildings. Journal of Analytical and Applied Pyrolysis, 287, 173–196. https://doi.org/10.1177/0192513X12437708
T.W. Keithley, W.B. Cowan, and E. L. F. (1963). OPERATING ROOM VENTILATION EVALUATED. Architectural Record.
Wang, Y., Li, Y., Zhou, L. (2015). Pressure gradient control and energy-saving operation strategy study on a multi-zone cleanroom. Procedia Eng. 121, 1998–2005. https://doi.org/10.1016/j.proeng.2015.09.198
Watt, J. (1933). The ventilation, heating and lighting of hospital wards. Proceedings of the Royal Society of Medicine, 1411–1426.
West, P. (1924). Modern trend in the sience of ventilation. Journal of Americal Society of Heating and Ventilation, 30(6).
Whitcher, C., Piziali, R., Sher, R., & Moffat, R. (1975). Development and evaluation of methods for the elimination of waste anesthetic gases and vapors in hospitals. https://www.cdc.gov/niosh/nioshtic-2/00047939.html
Whyte, W.M., Ward, S., Whyte, W.M., Eaton, T. (2014). Decay of airborne contamination and ventilation effectiveness of cleanrooms. Int. J. Vent. 13, 211–220. https://doi.org/10.1080/14733315.2014.11684049
Woods, J. E., Brayman, D. T., Rasmussen, R. W., Reynolds, G. L., & Montag, G. M. (1986). Ventilation Requirements in Hospital Operating Rooms - Part I: Control of Airborne Particles. ASHRAE Trans. 92(pt 2A), 396–426.
Yaglou, C. P., Drinker, P., & Blackfan, K. D. (1930). Application of Air Conditioning to Premature Nurseries in Hospitals. Am. Soc. Heating & Ventilating Engineers J., Sect. Heating, Piping & Air Conditioning, 2, 605.
Yang, C., Yang, X., Zhao, B. (2015). The ventilation needed to control thermal plume and particle dispersion from manikins in a unidirectional ventilated protective isolation room. Build. Simul. 8, 551–565. https://doi.org/10.1007/s12273-014-0227-6
Zhao, F.Y., Cheng, J., Liu, B., Huang, Z.R., Li, X. (2020). Indoor airflow and pollutant spread inside the cleanroom with micro-porous supplying panel and different ventilation schemes: Analytical, numerical and experimental investigations. J. Build. Eng. 31, 101405. https://doi.org/10.1016/j.jobe.2020.101405
Zhou, L., Sun, W., Huang, C., Li, H., Zou, Z., Wu, C. (2017). Studies on comparison of particle concentration models for cleanroom. Procedia Eng. 205, 3308–3315. https://doi.org/10.1016/j.proeng.2017.10.343
Zhou, L., Sun, W., Wu, C., Li, H., Zou, Z., Huang, C. (2020). General particle concentration model and experimental validation for cleanrooms. Sādhanā 45, 198. https://doi.org/10.1007/s12046-020-01398-y