

CANADIAN CENTRE FOR BUILDING EXCELLENCE

Engineering Health and Efficiency

Filtration and Air Cleaning in the Age of COVID-19

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Ref: Allergy Cosmos

“Reduce up to 99% of allergies, odors, mold, germs, and other contaminants.”

“40X better than a HEPA filter”

“Ions: Mother Nature's Little Air Scrubbers.”

“The only air purifier to clean a whole room.”

“True-HEPA rated.”

“Our technology is in The Whitehouse”

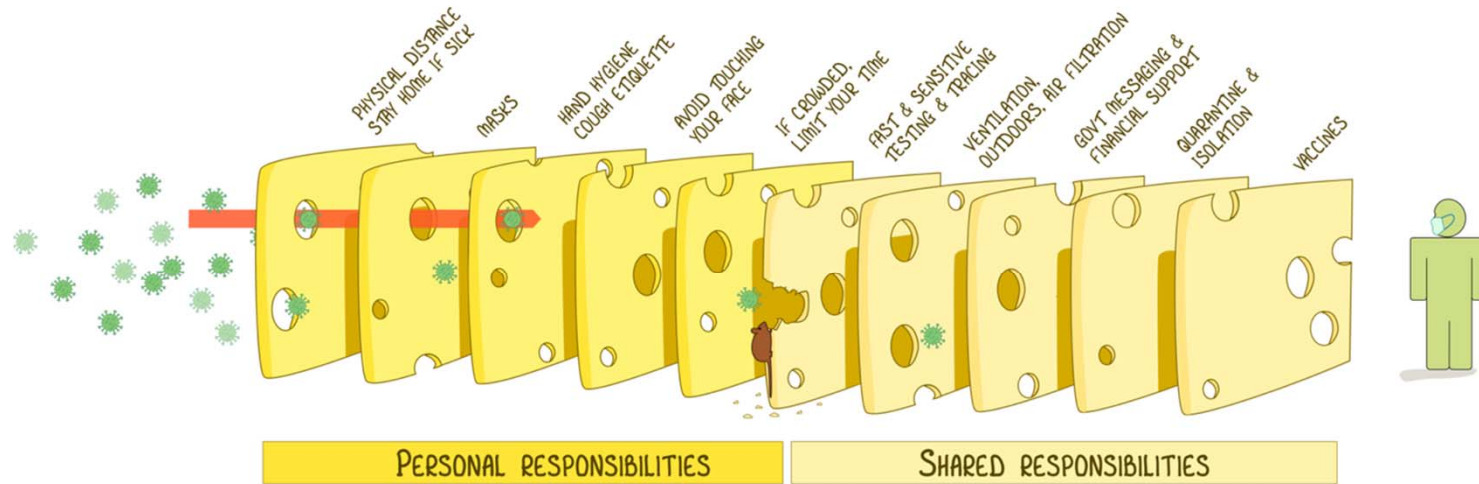
“Captures and destroys pollutants 1000 times smaller than HEPA filters.”

Seeing Through the Jungle

- Filters/air cleaners are not silver bullets
- Effective filtration is one part of a risk management strategy
 - Achieving effectiveness = understanding context
- Strong evidence for filters & UV, limited evidence for other technologies
 - Any technology can be used well or poorly

THE SWISS CHEESE RESPIRATORY VIRUS PANDEMIC DEFENCE

RECOGNISING THAT NO SINGLE INTERVENTION IS PERFECT AT PREVENTING SPREAD



EACH INTERVENTION (LAYER) HAS IMPERFECTIONS (HOLES).
MULTIPLE LAYERS IMPROVE SUCCESS.

IAN M MACKAY
VIROLOGYDOWNUNDER.COM
WITH THANKS TO JODY LANARD, KATHERINE ARDEN & THE UNI OF QLD
BASED ON THE SWISS CHEESE MODEL OF ACCIDENT CAUSATION, BY JAMES T REASON, 1990
VERSION 3.0
UPDATE: 24OCT2020

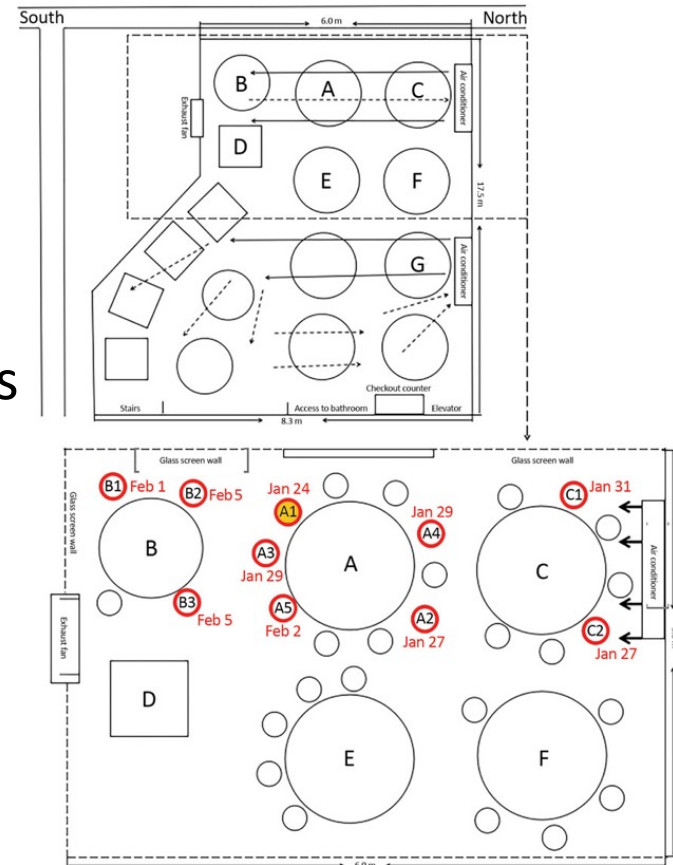
- Filters do not prevent against close contact transmission
- Filters are not a replacement for mask wearing, physical distancing, surface cleaning

Can filtration even remove viruses?

- Isn't the virus too small to filter?
- Don't larger droplets settle quickly?
- Is it airborne?
- Can it be transmitted long-ranges indoors

239 Experts With One Big Claim: The Coronavirus Is Airborne

New York Times July 4, 2020



Lu et al. (2020) *Emerg Infect Dis.*

Viruses Have Been Found on Filters

Detection of viruses in used ventilation filters from two large public buildings

Sagar M. Goyal, DVM, PhD,^a Senthilvelan Anantharaman, DVM, PhD,^a M. A. Ramakrishnan, DVM, PhD,^a Suchitra Sajja, PhD,^a Seung Won Kim, PhD,^b Nicholas J. Stanley, MS,^c James E. Farnsworth, MS,^c Thomas H. Kuehn, PhD,^c and Peter C. Raynor, PhD^d
St. Paul and Minneapolis, Minnesota

American Journal of Infection Control

Volume 39, Issue 7, September 2011, Pages e30-e38

Detection of Adenoviruses (AdV) in Culture-Negative Environmental Samples by PCR during an AdV-Associated Respiratory Disease Outbreak

Marcela Echavarria, Shellie A. Kolavic, Steven Cersovsky, Felicia Mitchell, Jose L. Sanchez, Christina Polyak, Bruce L. Innis, Leonard N. Binn

JOURNAL OF CLINICAL MICROBIOLOGY, Aug. 2000, p. 2982–2984

Detection of respiratory viruses on air filters from aircraft

T.M. Korves, D. Johnson, B.W. Jones, J. Watson, D.M. Wolk, G.M. Hwang

Conclusion: In some cases, influenza and rhinovirus RNA can be detected on aircraft air filters, even more than 10 days after the filters were removed from aircraft.

| <https://doi.org/10.1111/j.1472-765X.2011.03107.x> |

Letters in Applied Microbiology **53**, 306–312

Identification of SARS-CoV-2 RNA in Healthcare Heating, Ventilation, and Air Conditioning Units

Patrick F Horve, Leslie Dietz, Mark Fretz, David A Constant, Andrew Wilkes, John M Townes, Robert G Martindale, William B Messer, Kevin Van Den Wymelenberg

doi: <https://doi.org/10.1101/2020.06.26.20141085>

	Pre-Filters		Final Filters	
	Total Number (n)	Number Positive (%)	Total Number (n)	Number Positive (%)
	20	7 (35)	12	2 (16.67)
Cumulative Gene Copies (T)	354.8 (34.2)		103.2 (86.2)	

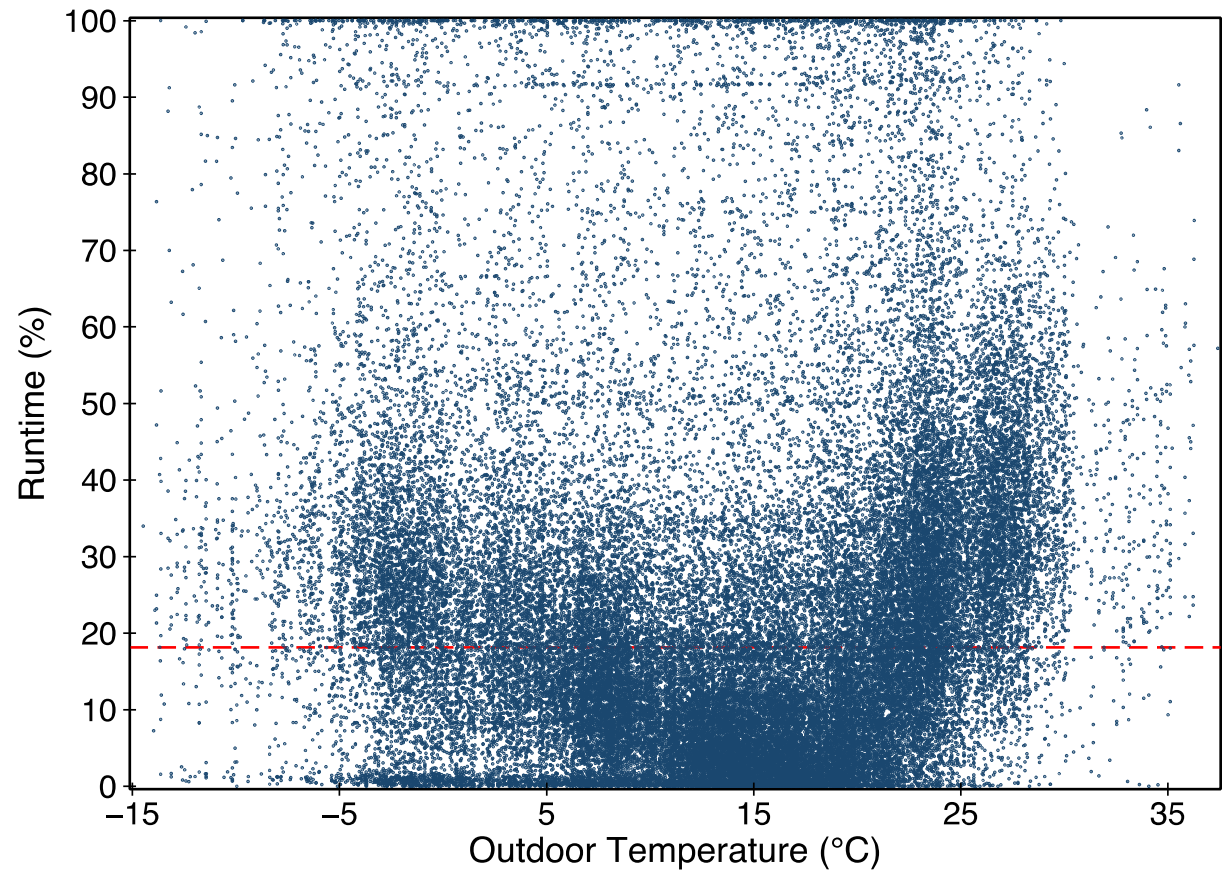
Context is Everything

- The virus/particle/droplet/contaminant has to get to the filter/air cleaner
- The air cleaner has to remove the virus
- The removal to the device has to contribute substantially to overall removal

Airflow, In-situ efficiency, Effectiveness

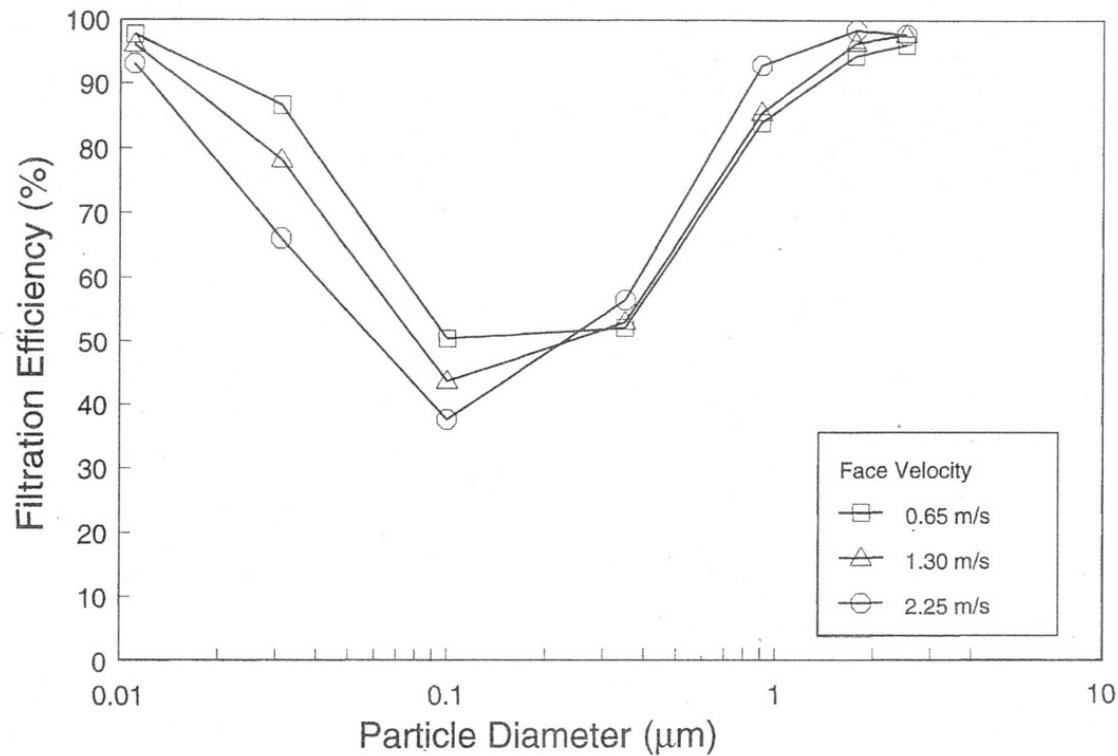
Does Air Go Through the Filter?

- Airflow rate
- Runtime



Touchie and Siegel (2018) *Indoor Air*

Efficiency: Classic U-shaped Curve



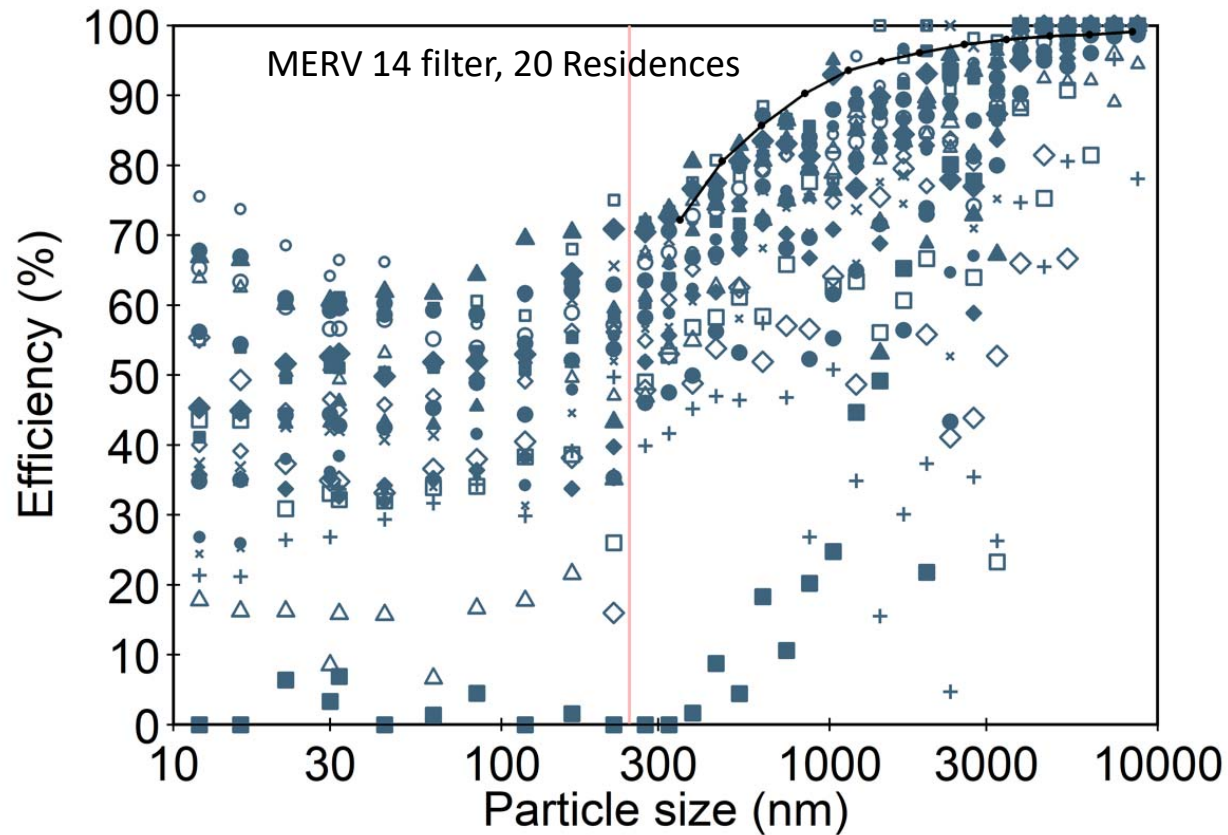
Ref: Hanley et al. (1994) *Indoor Air*

Table 12-1 Minimum Efficiency Reporting Value (MERV) Parameters

Standard 52.2 Minimum Efficiency Reporting Value (MERV)	Composite Average Particle Size Efficiency, % in Size Range, μm		
	Range 1 0.30 to 1.0	Range 2 1.0 to 3.0	Range 3 3.0 to 10.0
1	N/A	N/A	$E_3 < 20$
2	N/A	N/A	$E_3 < 20$
3	N/A	N/A	$E_3 < 20$
4	N/A	N/A	$E_3 < 20$
5	N/A	N/A	$20 \leq E_3$
6	N/A	N/A	$35 \leq E_3$
7	N/A	N/A	$50 \leq E_3$
8	N/A	$20 \leq E_2$	$70 \leq E_3$
9	N/A	$35 \leq E_2$	$75 \leq E_3$
10	N/A	$50 \leq E_2$	$80 \leq E_3$
11	$20 \leq E_1$	$65 \leq E_2$	$85 \leq E_3$
12	$35 \leq E_1$	$80 \leq E_2$	$90 \leq E_3$
13	$50 \leq E_1$	$85 \leq E_2$	$90 \leq E_3$
14	$75 \leq E_1$	$90 \leq E_2$	$95 \leq E_3$
15	$85 \leq E_1$	$90 \leq E_2$	$95 \leq E_3$
16	$95 \leq E_1$	$95 \leq E_2$	$95 \leq E_3$

ASHRAE Standard 52.2-2017

Lab Efficiency is Not In-situ Efficiency



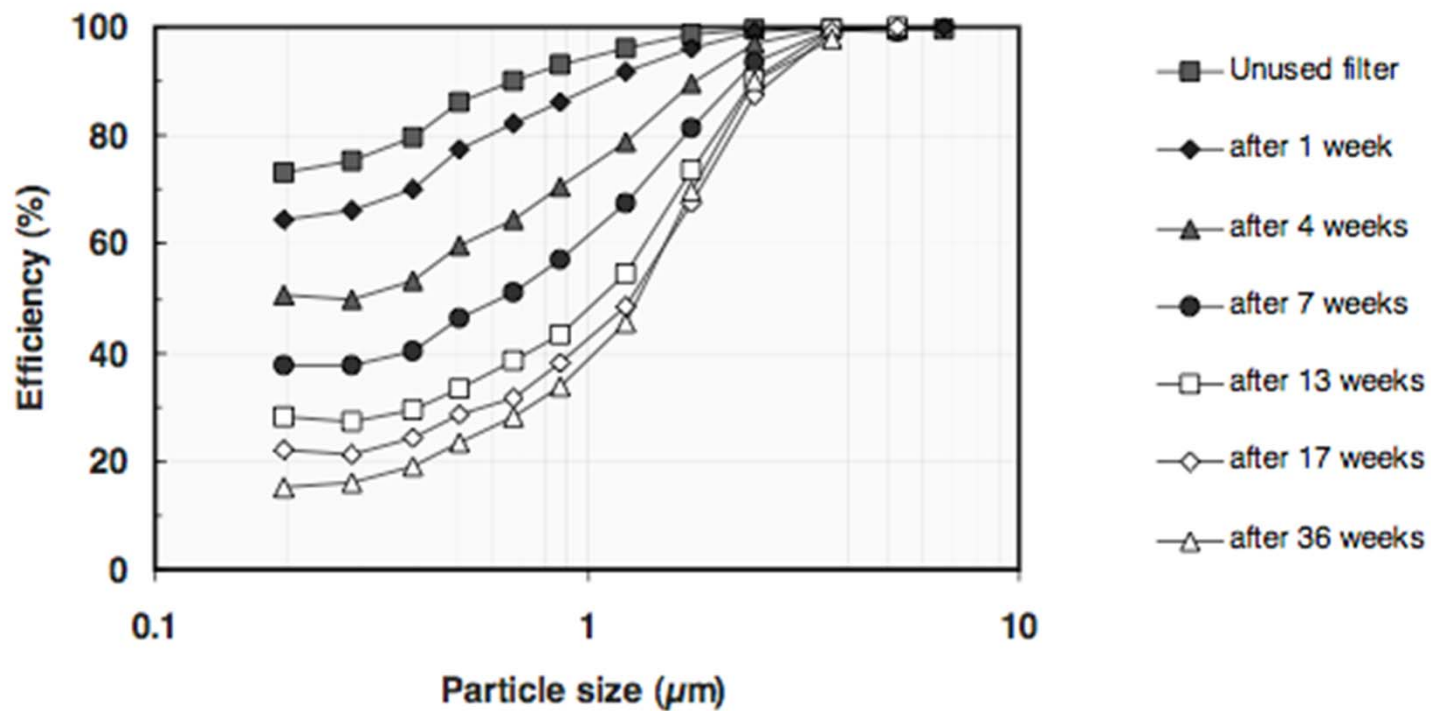
Li and Siegel (2020) *Indoor Air*

Why Not?

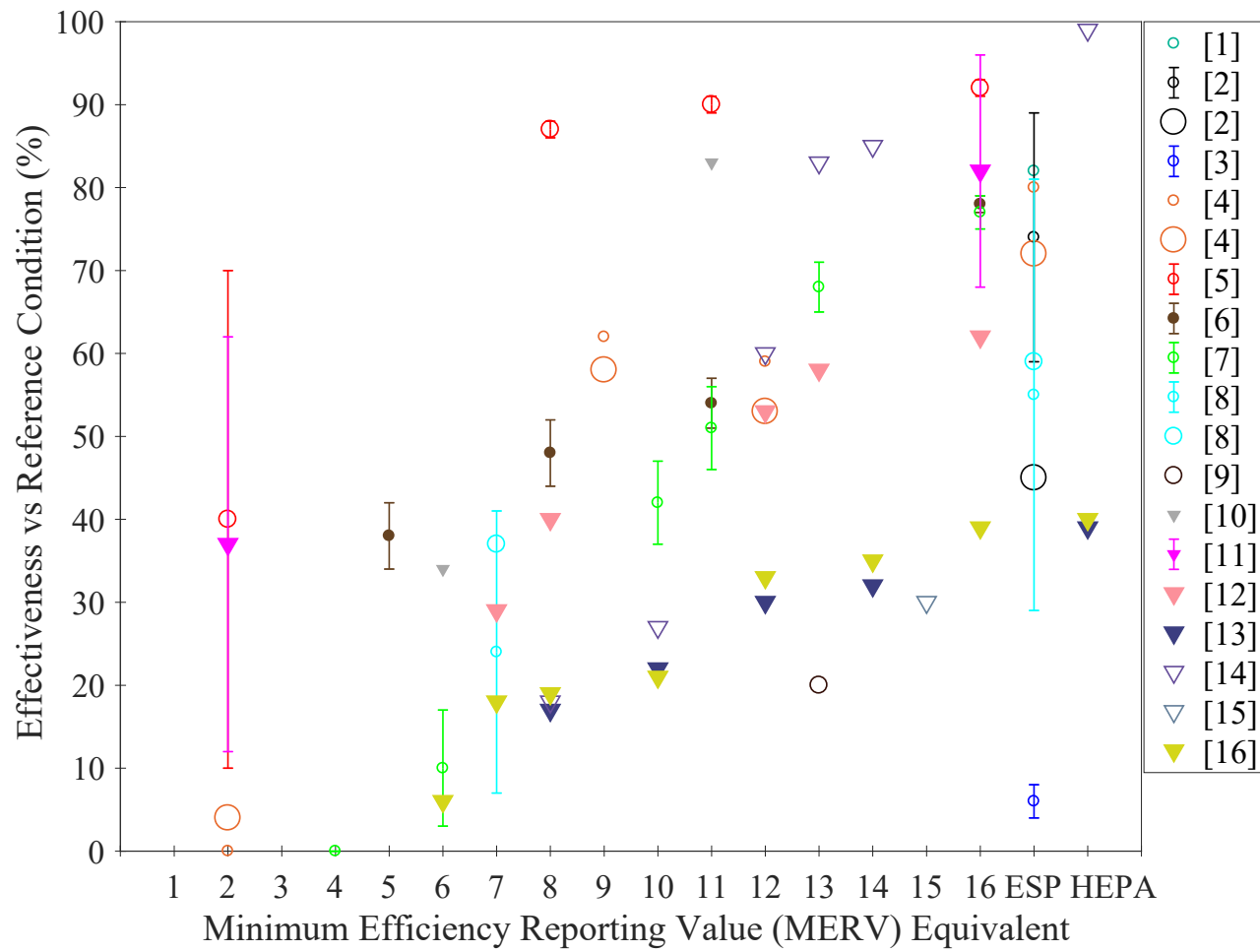


Image: Courtesy Geoffroy Allard

Efficiency: Filter Aging



Ref: Lehtimäki et al. (2002) ASHRAE RP-1189 Report



Alavy and Siegel (2019) *Sci Tech. Built Environ.*

What About Other Air Cleaning Technologies

- Photocatalytic oxidation
- Plasma
- Ionization

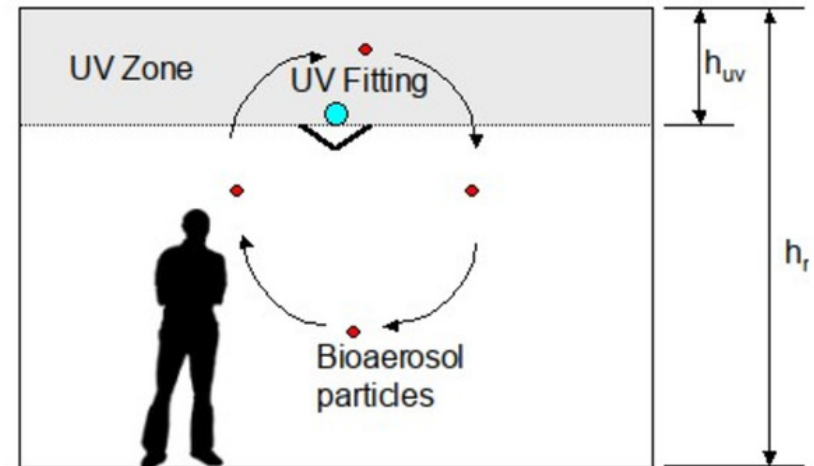
This is a suitable place to give a most earnest warning against the use of so-called secret remedies and patent medicines.... Pettenkofer (1883)

- These are **not** terms with firm definitions
- There is not independent evidence of efficacy
- There is evidence of harm (ozone emission, ion concentration, byproduct formation)

Buyer Beware.....

What About UV?

- Basic principle: use short wavelength lamps to break down microorganisms
- Four common use cases
 - ~~1. Coil irradiation~~
 2. Upper room
 3. In-duct
 - ~~4. Portable~~
- Manage airflow/size properly
- Maintenance is key
- Potential for ozone emission



<https://peerj.com/articles/10196/>



Arch News

Two Final Points

1. We have a serious supply/procurement problem
 - Gap is being filled with some less-than-savory products
 - Better use a lower efficiency filter well than a higher efficiency filter poorly
2. Change filters often and carefully
 - Wear PPE, turn fans off, ventilate mechanical room, dispose of used filters

Install a good filter properly, use it well, make sure lots of air goes through it, change it frequently (carefully). Don't rely on it as the only approach. Avoid alternative technologies unless you have independent confirmation that they work.