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COVID-19 guidance & case studies for specific space types

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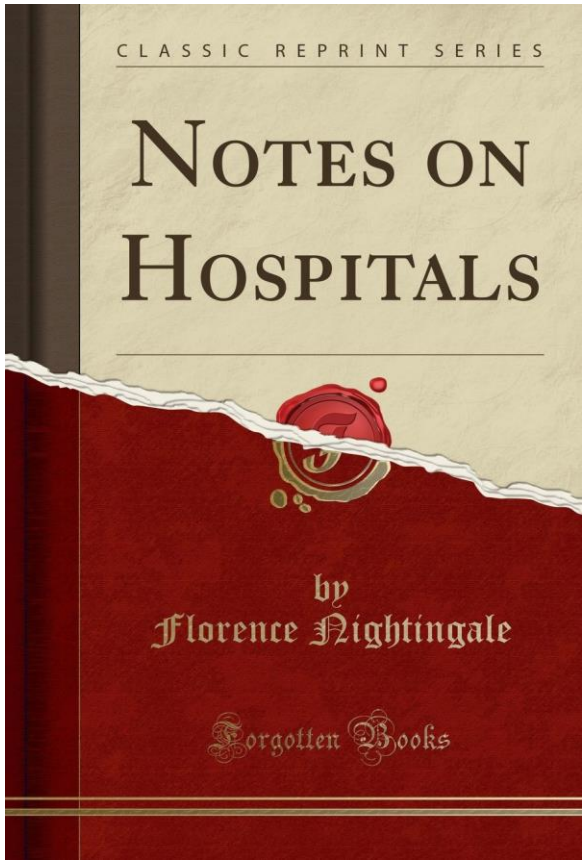
'Those who cannot remember the past are condemned to repeat it'

(George Santayana)

Back in time: Florence Nightingale



Environmental theory:

'There are five essential points in securing the health of buildings:

- Pure air

- Pure water

- Efficient drainage

- Cleanliness

- (Sun) light.

Without these, no building can be healthy.'

source: Nightingale, 1859

Fast forward to 2020: China buddhist bus case

= COVID-19 infected person

One person infects **18** others during a bus ride within 2 x 50 minutes (!)

Probable cause: *insufficient ventilation / system in recirculation mode*

Source: Shen et al, 2020

Policy effects

ECDC (june, 2020):

'HVAC systems may have a complementary role in decreasing transmission in indoor spaces by increasing the rate of air change, decreasing recirculation of air and increasing the use of outdoor air.'

Angela Merkel (september, 2020):

'Wir werden ein Schwerpunkt auf das thema Luftung setzen, denn wir wissen dass die aerosole bei Corona eine grosse Rolle spielen'

Umwelt Bundesamt

Für Mensch und Umwelt

Stand: 12. August 2020

Das Risiko einer Übertragung von SARS-CoV-2 in Innenräumen lässt sich durch geeignete Lüftungsmaßnahmen reduzieren

Stellungnahme der Kommission Innenraumlufthygiene am Umweltbundesamt

Der Herbst naht und das private und gesellschaftliche Leben wird sich wieder vermehrt in Innenräume verlagern. Der Schulbetrieb kehrt - unter länderspezifischen Bedingungen - zum regulären Unterricht in Klassenräumen zurück. Auch in geschlossenen Räumlichkeiten wie Großraumbüros, Hörsälen, Sportstätten, Theatern, Kinos und Restaurants ist vermehrt mit Versammlungen und Veranstaltungen zu rechnen. Angesichts der weiter bestehenden SARS-CoV-2-Pandemie sind in Innenräumen jedoch Vorsichtsmaßnahmen zu treffen. Das sachgerechte Lüften und die sachgerechte Anwendung von Lüftungstechniken (RLT-Anlagen) spielen dabei neben dem Tragen einer Mund-Nasen-Bedeckung und dem Einhalten der Hygiene- und Abstandsregeln eine entscheidende Rolle.

- **Die folgenden Empfehlungen der Innenraumlufthygiene-Kommission (IRK) am Umweltbundesamt sollen Raumnutzenden und Gebäudebetreibenden helfen, sich richtig zu verhalten, um das Risiko für SARS-CoV-2-Übertragungen und damit auch das Risiko für daraus resultierende Erkrankungen deutlich zu verringern.**

Die pandemische Ausbreitung des Virus SARS-Co… berufliches und gesellschaftliches Leben massiv … beeinträchtigt. Das Robert-Koch-Institut (RKI) ha… internationaler Wissenschaftler*innen den mögli… von SARS-CoV-2 über Aerosole in der Luft erkann… Auch die Weltgesundheitsorganisation (WHO) w… CoV-2 neben der direkten Tröpfcheninfektion au… Partikel übertragen werden kann [3].

source: www.ecdc.org & www.umweltbundesamt.de

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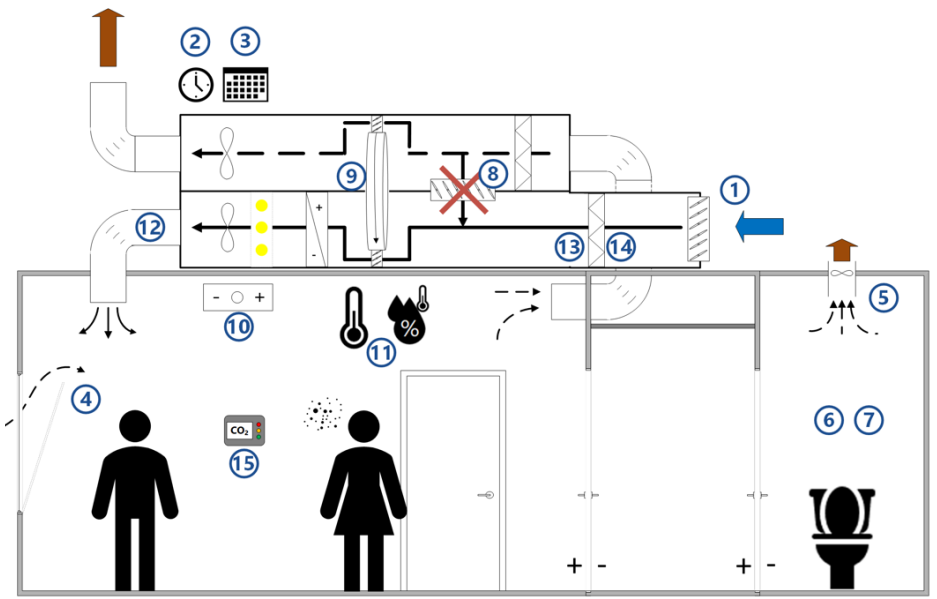
Prevention & REHVA Guidance

Recognizing the aerosol / airborne route implies that mitigation measures should be taken, generic ones described here https://www.rehva.eu/activities/covid-19-guidance:

5 Summary of practical measures for building services operation during an epidemic

1. Provide adequate ventilation of spaces with outdoor air
2. Switch ventilation on at nominal speed at least 2 hours before the building opening time and set it to lower speed 2 hours after the building usage time
3. At nights and weekends, do not switch ventilation off, but keep systems running at a lower speed
4. Open windows regularly (even in mechanically ventilated buildings)
5. Keep toilet ventilation in operation 24/7
6. Avoid open windows in toilets to maintain the right direction of ventilation
7. Instruct building occupants to flush toilets with closed lid
8. Switch air handling units with recirculation to 100% outdoor air
9. Inspect heat recovery equipment to be sure that leakages are under control
10. Adjust fan coil settings to operate so that fans are continuously on
11. Do not change heating, cooling and possible humidification setpoints
12. Carry out scheduled duct cleaning as normal (additional cleaning is not required)
13. Replace central outdoor air and extract air filters as normal, according to the maintenance schedule
14. Regular filter replacement and maintenance works shall be performed with common protective measures including respiratory protection
15. Introduce an IAQ sensor network that allows occupants and facility managers to monitor that ventilation is operating adequately.



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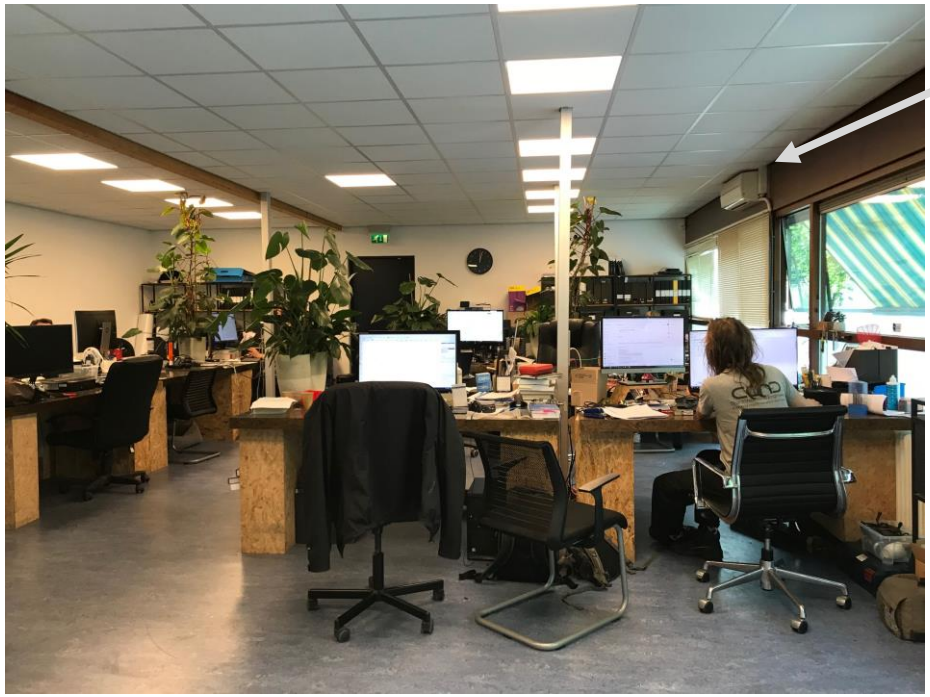
LEARNING FROM PAST OUTBREAKS

Office X



14 employees in total;
mid March one person was infected during skI holiday trip

8 collegues also infected within 3 days

POSSIBLE CAUSES ARE?

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Major problem: limited fresh air supply in WINTER

'Dauerluftung' closed most of the winter
(and no mechanical exhaust in the room, in toilets etc)

Measured air exchange rate July 2020
(with Dauerluftung OPEN): ~2

Estimated air exchange rate March 2020
(idem CLOSED): <0,5

	Steady state CO2 concentration	Air exchange rate	P(inf.) Wells Riley
July situation	800 ppm*	2	7-10%
March situation	1800 ppm**	<0,5	20-45%

**measured* ***estimated* ****depends partly upon assumption irt patient 0 talking a lot or not*

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RISK INVENTORY PROJECTS

Consultation room CASE

- Internal room in city hall
- No (operable) windows
- Used for one-on-one meetings civil servants with citizens
- Mechanically ventilated space
- Meetings can last up to 1,5 hours
- Volume room: +/- 25 m^3

Conclusions

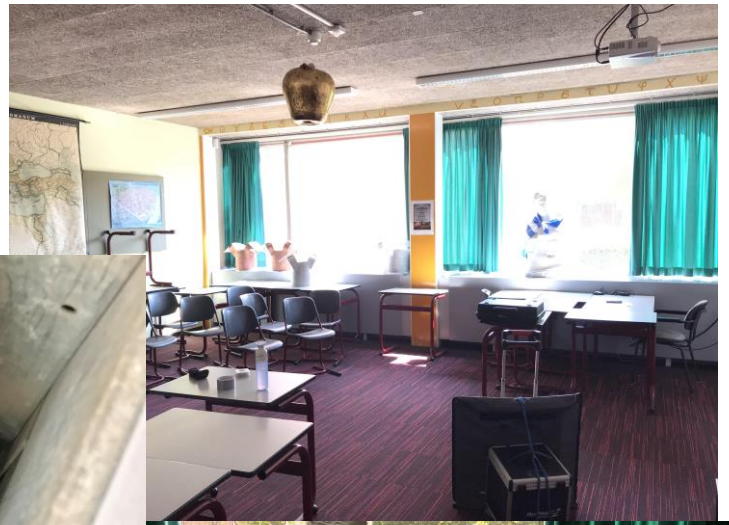
- Measured fresh air supply: **7 m³ / hr per persoon**
- Reference value NL building code: 14,4 m³/hr per persoon
- Challenge: lots of **talking** (= elevated virus emission risk)
- Advice: use OTHER rooms

1	2	17	18	19	20	21	22	23	24	25	
Ruimte nr.	Type ruimte	Ventilatie voud	Q per m²	Q pp COVID	Q pp normaal	BB eis nieuwbw	Voldoet?	BB eis best. bw.	Voldoet?	BB eindscore	
		[-]	[m³/h/m²]	[m³/h pp]	[m³/h pp]	[m³/h pp]		[m³/h pp]			
Begane grond											
0.01	Overlegruimte	0,8	2,2	7	**5**	14,4	Nee	7,6	Nee	**Rood**	**X**
0.02	Overlegruimte	0,8	2,2	7	**5**	14,4	Nee	7,6	Nee	**Rood**	**X**

Ruimte nr.	Type ruimte	Oppvlakte [m²]	Te openen raam?	Wells Riley besmettingskans bij I=1	Besmettingskans score
Begane grond					
0.01	Overlegruimte	9	Nee	**61%**	Rood
0.02	Overlegruimte	9	Nee	**61%**	Rood

Classroom CASE

- Secondairy school
- No operable windows
- Outdated mechanical ventilation system
- Length of lessons: 80-160 minutes



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Conclusions

- Measured fresh air supply: **7-11 m³/hr per persoon**
- Substantially less than building code /'Frisse Scholen PvE' requirements
- Good news: from january > new building designed at 'class A level'
- Advice: till X-mas rent portable air cleaners (HEPA / electrostatic filter type)

Ruimtenr.	Functie	Aantal personen	Gemeten Ventilatie-debiet [m³/uur]	Ventilatie per persoon [m³/uur]	Voorschriften bouwbesluit bestaande bouw pp. [m³/uur]	Voldoet?	PvE Frisse Scholen Klasse C [m³/uur/pp]	Voldoet?
001	Klaslokaal	31	275	9	12,4	Nee x	21,6	Nee x
002	Klaslokaal	31	331	11	12,4	Nee x	21,6	Nee x
109	Klaslokaal	31	205	7	12,4	Nee x	21,6	Nee x

Intermezzo

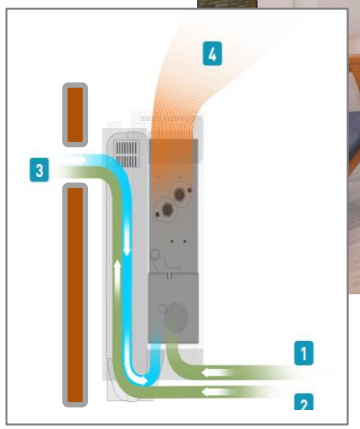
NL school ventilation requirements & Wells Riley infection risk estimate assuming 1 infected person present

Scenario	Total Fresh Air Supply (m3/h)	Air Exhange Rate (AER)	Steady state CO2 conc. (ppm)	Total class time: 1,5 hours		Total class time: 3,0 hours		Total class time: 8,0 hours	
				P(inf) when quiet	P(inf) when talking	P(inf) when quiet	P(inf) when talking	P(inf) when quiet	P(inf) when talking
Excellent fresh air supply (8,5 l/s per person)	765	4,9	1000	**1,0%**	**2,5%**	**2,0%**	**4,9%**	**5,3%**	**12,6%**
Basic fresh air supply (6 l/s per person)	550	3,7	1200	**1,5%**	**3,5%**	**2,7%**	**6,5%**	**7,0%**	**16,5%**
Mediocre fresh air supply (3,5 l/s per person)	310	2,1	1800	**2,3%**	**5,7%**	**4,6%**	**11,1%**	**11,8%**	**27,0%**
Very low fresh air supply (1,7 l/s per person)	150	1,0	3200	**4,6%**	**11,1%**	**9,0%**	**21,0%**	**22,3%**	**46,8%**

Living room CASE

- Living room in nursing home
- **Demand-controlled** system, integrated in facade (normally in ‘eco-mode’)
- Setpoint > 1000 ppm
- Combination of fan coil unit (right) with fresh air supply unit (left)
- *Facility manager:*
  ‘cross infection risk due to recirculation & high velocity air currents’

This is just a picture of an ad random living room In a nursing home; no relation whatsover with the specific project that is described here



Demand (CO2) controled decentralised ventilation

Conclusions

- ‘Air current hypothesis’ rejected
- Main problems seemed to be: ventilation system ‘off’ most of the time
- Actual fresh air supply per person much lower than building code value (22,3 m3/hr pp)
- Advice 1: reprogram the ventilation units / fresh air supply settings
  (and start using the heating/cooling function again)
- Advice 2: monitor IAQ with ‘CO2 traffic lights’ in all living rooms, meeting rooms etc