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Fachbereich Verwaltung
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Fachbereich AKTUELL

FBVW-502

Infection prevention: recommendations for ventilation at indoor workplaces

Indoor climate Subcommittee
Last updated: 16 February 2024

Infectious diseases present a general risk to all human beings, and safeguarding against them is a part of civil protection and public health activity. During the seasonal period of high infection incidence, a risk of contagion exists in all areas of life, including in public places, on public transport, at work and during leisure time. Employers' scope for influencing the incidence of infection is therefore limited.

Regular ventilation has the effect of replacing indoor air with fresh outdoor air. At the same time, used air, contaminants from materials (such as furniture and floor coverings), particles and biological substances (such as pathogens) are transported outdoors, as a result of which good indoor air quality is assured. The German Ordinance on Workplaces (ArbStättV) and the supporting ASR A3.6 Technical Rule for workplaces, Ventilation [1]**, requires the breathing air in enclosed indoor working areas to be conducive to good health. When the incidence of infection is high, such as during an epidemic or a rash of colds or influenza outbreaks in the winter months, sufficient air exchange is particularly important in order to reduce the risk of infection.**

The German Federal Ministry of Labour and Social Affairs (BMAS) recommends that the proven safety measures set out in the SARS-CoV-2 Occupational Health and Safety Ordinance (CoronaArbSchV) should continue to be applied, even following the ordinance's withdrawal [2]**. This Fachbereich AKTUELL recommends ventilation practices by which the risk of contagion caused by airborne pathogens, such as SARS-CoV-2 and influenza viruses, can be reduced. The focus lies upon indoor workplaces where the indoor climate does not have to be influenced for technical reasons, in contrast for example to the food industry.**

Contents

1 Airborne transmission routes

Some pathogens, such as viruses including SARS-CoV-2 [3], are spread by airborne transmission and inhalation of droplets and aerosols produced during breathing, coughing, speaking and sneezing. Droplets are > 5 µm in size; aerosols are ultrafine airborne liquid particles and droplet nuclei < 5 µm in diameter. The distinction between the two forms is fluid.

Owing to their dimensions, droplets fall to the ground more quickly. Aerosols remain in the air longer and can therefore spread to all parts of closed rooms [4]. The likelihood of exposure to infectious droplets and aerosols is particularly great within a radius of 1 to 2 meters from an infected person. Maintaining a minimum distance of 1.5 metersfrom other persons is therefore important. Where persons spend longer periods in poorly ventilated or unventilated indoor spaces, distribution and accumulation of contaminated aerosols throughout the indoor air also increases the probability of transmission over distances greater than 2 meters. This hazard can be reduced by adequate ventilation of the rooms with outside air (dilution effect).

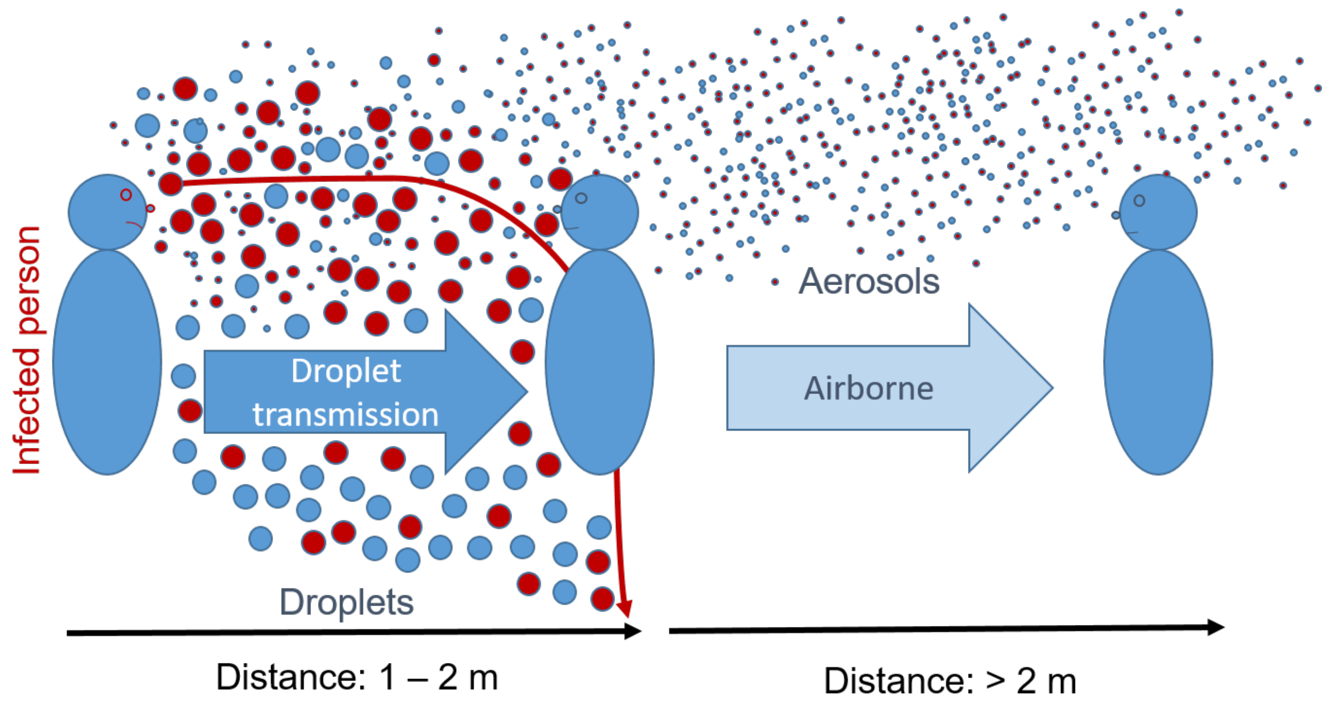

Figure 1: Airborne transmission of infectious agents by droplets at a distance of 1 to 2 meters and by aerosols at a distance of > 2 meters.

2 Ventilation

A distinction is drawn between natural and mechanical ventilation.

2.1 Natural ventilation

Natural ventilation is generally achieved by windows. Rapid air exchange through wide-open windows and ideally also wide-open doors is the most effective form of natural ventilation. Bursts lasting a few minutes are usually sufficient. Ventilation through tilted windows is less effective, but can be useful as a supplement to intermittent ventilation through wide-open windows to prevent a strong and excessively rapid rise in virus concentrations [5], [6]. An important aspect to consider is that the effectiveness of natural ventilation depends on the weather conditions, such as the wind direction and the temperature difference between the indoor and outdoor air. The dimensions of the open window areas and the room geometries also influence the effectiveness of natural ventilation; the corresponding limits of natural ventilation are described in ASR A3.6, Ventilation. During an epidemic or period of high infection incidence, the CO_2 concentration can serve as a reference for determining the ideal ventilation strategy for reducing aerosol concentrations. However, the CO_2 value does not provide a clear indication of the actual concentration of aerosols contaminated with viruses.

ASR A3.6 recommends ventilation at hourly intervals for offices and similar rooms and at intervals of 20 minutes for conference and seminar rooms. The air quality can be monitored by measurement of the CO_2 concentration, for example with a CO_2 traffic light indicator. ASR A3.6 states that a CO_2 concentration of up to 1,000 ppm is acceptable. During an epidemic, the concentration should be kept below this level if at all possible. This entails more intensive and frequent ventilation.

Further information can be found in the Fachbereich AKTUELL on the use of CO_2 measurement to evaluate ventilation measures [7]. CO_2 meters should be checked regularly for their serviceability and calibrated where applicable according to the manufacturer's specifications.

Recommendations

- Regular intermittent ventilation bursts over the entire window area for 3 minutes in winter, 5 minutes in spring/autumn and around 10 minutes in summer.
- Thoroughly ventilate rooms used by several people, such as break rooms, stand-by rooms and canteens, and in particular conference and seminar rooms, before and after use.
- Adjust ventilation intervals according to the number of people in the room, e. g. every 20 minutes for multiple-occupancy offices.
- A CO_2 traffic light indicator can be used to measure the CO_2 concentration in the room as an aid to checking the air quality. Alternatively, the CO_2 concentration and suitable ventilation intervals can be calculated, for example with the aid of the DGUV's CO_2 Timer app [8] or the BGN ventilation calculator [9].

2.2 Mechanical ventilation

Mechanical ventilation involves use of a central or local HVAC system to route filtered fresh air from outdoors continuously into the indoor area. When air conditioning systems are used, the air can also be heated, cooled, humidified and/or dehumidified. In contrast to natural ventilation, correctly adjusted HVAC systems ensure a continuous and adequate exchange of air, whatever the weather conditions.

The risk of a properly adjusted, operated and maintained HVAC system transmitting infectious agents is considered low [10]. HVAC systems should not therefore be switched off. On the contrary, the supply of outdoor air through the system should be increased, and operation of such systems in recirculation mode avoided completely or reduced as far as possible [11]. An adequate supply of outdoor air is the only means of reducing the concentration of aerosols contaminated with the virus. Where HVAC systems partially recirculate the indoor air, rather than drawing solely upon fresh outdoor air for the air supply and discharging the entire exhaust air outdoors, aerosols contaminated with viruses are largely returned to the room. If recirculation of the air cannot be avoided, higher filtration classes should be used if possible, e. g. class ePM1 80 % (formerly F9) instead of class ePM1 50 % (formerly F7). Where technically possible, class H13 or H14 HEPA filters may also be used. The resulting higher filter resistance causes the flow rate to drop, however. Before a system is upgraded with H13 or H14 filters, a specialist company should therefore check whether this solution is in fact advantageous from a technical perspective.

Recommendations

- Ensure an adequate supply of outdoor air. Increase if necessary and avoid recirculation mode.
- Operate the HVAC system at rated capacity for at least two hours before and after the building is used.
- Do not switch off the ventilation when the building is not in use, e. g. at night or weekends; instead, operate it at reduced capacity.
- On systems with CO_2-based regulation, set the desired value to 400 ppm. This causes them to operate continuously at their rated capacity.
- Run the ventilation in sanitary rooms continuously.
- The operating points (heating, cooling, humidifying and dehumidifying) of air-conditioning systems do not need to be changed.
- Check heat exchangers for possible leaks.
- Observe the normal intervals for maintenance and inspection (manufacturer's information, VDI 6022 [12]). Additional cleaning of ventilation ducts is not necessary.
- Outdoor air filters need be replaced only as part of scheduled maintenance.
- Where recirculation mode cannot be avoided, higher filtration levels should be used if possible, e.g. class ePM1 80 % (formerly F9) instead of ePM1 50 % (formerly F7); where technically possible, class H13 or H14 HEPA filters can also be used. The increased pressure drop through these high-performance filters must be taken into account.
- Ensure protection of the maintenance personnel when the filters are changed.

3 Local and mobile air recirculation equipment

Mobile and local air recirculation equipment includes air conditioners (e. g. split air conditioners), fan heaters and fans (e.g. floor-standing fans). Air conditioners and fan heaters draw in the room air and return it to the room after treatment. Such air recirculation equipment is not generally equipped with filters capable of effectively filtering out or inactivating aerosols that may be contaminated with viruses. Fans generate a flow of air for cooling, particular in summer. Mobile and local air recirculation units do not constitute primary ventilation equipment [5]

Air recirculation equipment does not bring about an exchange of the indoor air with the outdoor air, but merely accelerates even distribution of the air in the room. In the absence of air recirculation equipment, air movement still takes place owing to the heat emitted by persons and electrical appliances present in the room and by the movement of persons, which cause the air in the room to be thoroughly mixed within a short space of time. Air recirculation equipment merely speeds up this process.

Recommendations

- Ensure an adequate supply of fresh air from outdoors.
- Use air recirculation equipment such as air conditioners, fan heaters or fans only in rooms occupied by a single person.
- Should air recirculation equipment nevertheless be used in rooms occupied by more than one person, a risk assessment must be performed of each case. Particular care must be taken here to ensure that air does not flow directly from one person to another, in order to avoid an increased risk of droplets or aerosols contaminated with the virus being transferred [6].

4 Air purification

Air purifiers are designed to remove particulate matter, gaseous compounds and microbial contaminants from the air, thereby enhancing the air quality [13]. A distinction can be drawn between filtration and other forms of air treatment, such as those employing ozone, cold plasma, electrostatic precipitation, ionization or UV-C radiation.

Air purifiers are generally used as local mobile air recirculation equipment in indoor areas. However, as already described in Chapter 3, the drawback is that their recirculating mode of operation does not transport any fresh air into the indoor area, but instead recirculates the existing air evenly throughout the room. Air purification is however a less effective means of reducing the viral load than the direct supply of fresh outdoor air. Air purification by way of filtration and air treatment with UV-C radiation is also used in HVAC systems.

To filter out viruses, air purifiers must be equipped with high-quality filters, e. g. ePM1 50 % (formerly F7) or ePM1 80 % (formerly F9), or better still, with a HEPA filter (H13 or H14) [10]. Air treatment with UV-C radiation can be a useful supplement to filtration, provided the operating parameters (such as the radiation dose) of the equipment used are known. In this case, care must be taken to ensure that the irradiation is of adequate duration, for example. The UV-C radiation must also not present a hazard to the workers.

The effectiveness of filtration in removing particles from the air has already been proven. Aerosols that may be contaminated with viruses are thus also removed.

Equipment employing other purification technologies (UV-C radiation, ionization, plasma filters, etc.) reduces the virus concentration by inactivating viruses. When such equipment is used, relevant evidence must be provided with regard to its efficacy, together with evidence that it does not release any substances hazardous to human health (e. g. ozone, nitrogen oxides) into the ambient air, and does not emit hazardous radiation. The relevant evidence should be based wherever possible on recognized testing methods (e. g. VDI EE 4300 Blatt 14 [14]).

We strongly advise against the use of air purification solutions employing disinfectants or hydrogen peroxide.

Further information on the use of air purifiers can be found in the DGUV's guidance document on the supplementary use of air purifiers for infection control during the SARS-CoV-2 epidemic [15] and the baua:Fokus publication on the use of mobile air purifiers for protection against infection [16].

Recommendations

- Before mobile air purifiers are procured, the possible use of more sustainable measures should be considered, such as upgrading with local ventilation equipment [16].
- Ensure an adequate supply of fresh air from outdoors.
- Consider the relationship between room size and air purifier capacity. In larger rooms, place mobile air purifiers close to the persons present. Consider the possible adverse effects of noise.
- Air purifiers employing filtration (e. g. class ePM1 50 %/ePM1 80 % filters, or better still, H13/H14 HEPA suspended particulate filters) are particularly suitable in this case.
- Where equipment employing other air purification technologies (UV-C radiation, ionization, plasma filters etc.) is used, suitable evidence of its efficacy must be furnished, and also that its use does not result in any substances hazardous to human health (e. g. ozone, nitrogen oxides) being released into the ambient air or hazardous radiation being emitted. Wherever possible, the evidence in question should be based on recognized test methods (e. g. [16]).
- We strongly advise against the use of air purification solutions employing disinfectants or hydrogen peroxide.
- Ensure that the air purifiers are maintained and serviced properly, particularly the filters. Regularly check the performance of the air purifier.

5 Climatic conditions

In accordance with the German Ordinance on workplaces (ArbStättV) and the associated ASRs A3.5, Room temperatures, and A3.6, Ventilation [1], the room temperature and breathing air of indoor working areas should be conducive to good health, and unacceptable draughts should not occur. During the epidemic and whilst the associated recommendation of increased ventilation of indoor areas applies, some impairment of employees' comfort and a possible increase in energy consumption must both be accepted in order for exposure to viruses in indoor air to be reduced and the health of employees safeguarded.

Air temperature and humidity are known to have a potential influence upon the activity of some viruses, and thus also upon the risk of infection. Influenza (flu) viruses, for example, remain in the air longer at low atmospheric humidities and temperatures and continue to be infectious [17]. SARS coronaviruses are generally [18] highly resistant to environmental influences. Studies of SARS-CoV-2 indicate that activity decreases only at low relative atmospheric humidities of under 30 % or high relative atmospheric humidities of over 70% and air temperatures above 30 °C [19]. The setting of such climate parameters is however not desirable, and is unacceptable for reasons of comfort and room hygiene.

The size of the droplets and the quantity of aerosols varies according to the atmospheric temperature and humidity. At lower atmospheric humidities, water evaporates more quickly, reducing the size of droplets contaminated with viruses and promoting the formation of potentially contaminated aerosols. However, current findings do not support the assumption that adjusting the relative atmospheric humidity to 40-60 % decisively reduces the activity of viruses such as influenza or SARS-CoV-2. It is therefore not advisable to humidify the air further in order to reduce the risk of infection from SARS-CoV-2, for example [10], [20]. Instead, sufficient and possibly increased ventilation should be ensured.

Recommendation

- Changing the climate parameters of central air conditioning systems is not beneficial and therefore not necessary.

6 Summary of the main recommendations

- Ensure an adequate supply of fresh air from outdoors by means of natural or mechanical ventilation.
- Where HVAC systems are used, reduce air recirculation to a minimum and avoid entirely if possible. Where mechanical air recirculation cannot be avoided, higher filter classes should be used, technology permitting, e. g. class ePM1 80 % (formerly F9) rather than ePM1 50 % (formerly F7), or alternatively class H13 or H14 HEPA filters.
- Operate HVAC systems at rated capacity for at least two hours before and after the building is used, and at reduced capacity at other times when the building is not in use.
- The indoor air quality can be checked by measurement of the CO_2 concentration. (Note: a CO_2 concentration of up to 1,000 ppm is acceptable; for the duration of the epidemic, the concentration should be kept below this level if at all possible.)
- The operating points (heating, cooling, humidifying and dehumidifying) of air-conditioning systems do not need to be changed.
- If possible, operate air recirculation equipment such as air conditioners (split air conditioners), fan heaters or fans only in rooms occupied by a single person, and even then ensure additional air exchange with outdoor air.
- Air purifiers should be regarded only as a supplementary protective measure for reducing the aerosol concentration in the room air, and not as a substitute for the necessary replacement of the indoor air with fresh air from outdoors. Before mobile air purifiers are procured, the possible use of more sustainable measures should be considered, such as upgrading with local ventilation equipment [16].
- Local mobile air purifiers must be equipped with a filter of at least class ePM1 50 %/ePM1 80 %, and preferably with an H13/H14 HEPA filter.
- Where equipment employing other air purification technologies (UV-C radiation, ionization, plasma filters, etc.) is used, suitable evidence of its efficacy must be furnished, and also that its use does not result in any substances hazardous to human health (e. g. ozone, nitrogen oxides) being released into the ambient air or hazardous radiation being emitted. The relevant evidence should be based on recognised testing methods wherever possible [14].
- We strongly advise against the use of air purification solutions employing disinfectants or hydrogen peroxide.

In addition to the recommendations for indoor ventilation stated in this Fachbereich AKTUELL, the familiar measures should still be observed, such as maintaining a distance of at least 1.5 m, observing hygiene measures, and wearing respiratory masks or medical face masks if the minimum distance cannot be maintained. On their own, intensive airing of rooms and engineered ventilation measures are not sufficient, and should be viewed as only one element for reducing the risk of infection for example with influenza viruses or SARS-CoV-2. Observance of the rules for distancing, hygiene measures and masks is of primary importance.

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