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Commentary on the Framework Hygiene Plan for Schools of the Bavarian State Ministry of Health and Care of November 13, 2020

On November 13, 2020, the framework hygiene plan for the implementation of the protection and hygiene concept for Bavarian schools was published [1]. The hygiene plan contains measures and instructions to prevent the widespread spread of corona virus in schools. Unfortunately, some statements are based on wrong assumptions and therefore some measures and hints do not prevent the large-scale spread of the coronavirus in schools, but actually promote it.

Direct infection over short distances while breathing, speaking or coughing

Under 4.3.2, the following statement can be read: "Partition walls, even between student seats, would significantly impede the circulation of air when ventilating; therefore, they are not allowed to be installed unless the classroom is equipped with an exhaust air system that sucks the exhaust air upwards.

First of all, it should be noted that the best possible protection against direct infection between adjacent persons who interact with each other for longer periods of time over short distances is a solid protective wall, as shown in Fig. 1. A protective wall is not permeable for aerosol particles! Due to the high level of protection, these transparent protective walls are already used in many parliaments, courtrooms, reception areas, stores, restaurants, medical practices and in many other areas for the effective protection of people. It is therefore not at all comprehensible why the most effective protection against direct infection should not be effective in schools, although it is recognized in many other working areas as the most reliable protection against direct infection.

It is claimed in [1] that the protective walls would impede the air circulation in classrooms. This assumption is physically incorrect, as has already been scientifically proven [2]. It is physically correct that due to natural convection and turbulence the mixing of the air in the room is always so strong that there is an almost perfect mixing of the room air. This mixing causes a very even decrease of aerosol particles in all areas of the room as soon as windows are opened or air purifiers are switched on [3, 4]. Especially the convection currents generated by the children through body heat and breathing as well as through their movement ensure that the mixing in the area of the protective walls is guaranteed and thus also the removal of the virus load. The assumption that there is a reduced air exchange in the area of the protective walls is therefore physically incorrect. The measurement results in [2] also clearly show that the decrease in aerosol particles in the room is independent of whether the room is equipped with chairs and tables only or additionally with people, bags, laptops and protective walls between adjacent places.

It is not understandable that the framework hygiene plan prohibits the use of the most effective methods to protect children and young people in schools from direct infection. It is regrettable that the omission of the most effective protection option is justified with unfounded arguments and that the state of the art and research is ignored. I would therefore urgently request that the framework hygiene plan be corrected and that the erection of appropriate transparent protective walls between neighboring children not only be permitted but recommended!

An even better protection against direct infection can be achieved if these protective walls are provided with a surrounding edge, as shown in Fig. 1. The protection of these transparent protective walls is so good that even the wearing of simple mouth-nose-coverings or surgical masks at the site is not necessary. I have studied masks very intensively and published the main research results in the Journal of Aerosol Science [5]. Our research results are even cited by the WHO and the CDC [6, 7, 8]. I have also lectured on the topic to the Royal Netherlands Academy of Arts and Sciences [9]. So I know very well what I am writing here. The simple masks currently recommended in schools to protect children usually provide good protection against direct infection when people talk face to face over a distance of 1.5 m. However, they offer very poor protection when people sit close to each other, as in school, because the aerosol particles are emitted from the side of the mask and flow directly into the face of the neighboring person, see Figure 2. This has now been confirmed by numerous independent researchers and I therefore refer to the generally accepted state of research. For this reason, transparent protective walls with a surrounding edge in schools offer much better protection against a direct infection than simple mouth-nose covers or surgical masks. The masks listed in [1] under 6.3, whose gap at the edge of the mask may be large enough to allow good breathing, pose a considerable risk when used in the classroom. A protective wall is absolutely necessary to prevent infection between adjacent persons wearing the masks described in [6.3].

It should also be remembered that teachers and children would feel much safer in the classroom if a truly effective protection concept were established in schools. Since mouth-nose-coverings or surgical masks do not offer any additional protection as soon as transparent protective walls are installed between adjacent places, they could also be removed without hesitation, as has long been common practice in state parliaments and courts. This would not only have a liberating effect, but also bring a piece of normality into the classroom. Furthermore, facial expressions would be visible again, which is of utmost importance especially in elementary school. Masks are only necessary when the teaching staff moves towards the children. In this case, however, the teaching staff should use particle-filtering half-masks, since only these offer effective protection against infection over a short distance [5]. The children would only need these masks when they leave the playground and walk through the school to the playground or when they travel to school by bus.

Indirect infection due to a high viral load in the room

In order to minimize the risk of indirect infection, the Federal Environment Agency (UBA) recommends that air exchange in schools should be implemented through regular ventilation with windows [10]. It also recommends an air exchange rate of 3 per hour, whereby it is expressly required that all air be exchanged per air exchange [10]. In areas where ventilation does not work sufficiently, e.g. because the windows are small, the UBA recommends room air cleaners. Room air cleaners have been used for many decades in hospitals and other work areas to remove viruses or other hazardous substances. It is therefore an established and recognized technology. The UBA is of the opinion that a 3-fold air exchange (AE) with window ventilation is equivalent to a 6-fold air exchange with room air cleaners [11]. However, this assumption is wrong. In both cases it is physically a mixed ventilation and therefore 3AE window < 6AE filter and not 3AE window = 6AE filter! Since an air exchange rate of 3 with impulse ventilation can only be achieved in the rarest of cases (strong wind or permanent high temperature difference between indoors and outdoors) with the methods specified by the UBA, and certainly not an air exchange rate of 6, which we and other scientists [9] consider necessary due to the danger of SARS-CoV-2, the use of air purifiers should also be recommended. Even the Indoor Air Hygiene Commission at the UBA (IRK) recommends that the used air should be replaced by fresh air five times per hour [12]. Mr. Moriske also admitted in a recent discussion with me that 2–3 air changes can only be achieved with large, wide open windows [13]. This shows that even the UBA does not believe in the protective effect of its own recommendations.

With suitable room air cleaners adapted to the spatial situation, an air exchange of 6 or more per hour can be achieved continuously in classrooms without making it uncomfortable or cold and without human intervention. With this technology it does not matter whether there are enough windows in the room and how strong the wind blows outside or how big the temperature difference between inside and outside is. With the method recommended by the UBA to open the windows every 20 minutes for 3–5 minutes, an AE of 6 per hour is rarely possible in practice and even an AE of 3 is often not achievable. The method recommended in the frame hygiene plan [1], i.e. airing the windows at least every 45 minutes for at least 5 minutes, will hardly lead to a ventilation level of 1 AE per hour according to technical

literature [14] and current measurements [2, 9]. This recommendation is therefore completely inadequate and puts children at high risk. The problem is therefore not the partition walls as claimed in [1], but the ventilation concept itself!

The UBA writes in [10] that with the correct ventilation and cross ventilation, the temperature in the room only drops by a few degrees. If this is the case, you should leave the room quickly, because the viruses are still in the room after ventilation! If there is 20° in a room and 0° outside and the windows are opened for a short time so that the mixed temperature in the room is still 15°, then this means that approximately 75% of the viruses are still in the room! In order to realize an air exchange rate of 1, the temperature in the example would have to drop to near 0°, since only in this case really all viruses are removed from the room in a short time. Studies that contradict these physical principles should be analyzed for systematic errors and the positioning of the measuring probes should be critically questioned. The recommendation to open the windows only briefly so that it does not get cold implies, with regard to the protection against infection, that the danger of infection remains. With this recommendation the children are exposed to a large danger and who would like to answer for that? The recommendation to stop airing when the temperature has dropped a few degrees thwarts all efforts to protect children from indirect infection.

The UBA writes [15]: "A reliable reduction of the SARS-CoV-2 virus exclusively by mobile air purification devices in classrooms has not been clearly proven based on the current state of knowledge. The UBA therefore continues to recommend window ventilation as a priority measure even in the cold season, despite all the shortcomings. It is quite astonishing that this filter technology, which has been established for decades, is not recognized by the UBA, even though these mobile air filters have been used in hospitals and micro-laboratories for exactly this purpose for decades. It is even more astonishing that the UBA explicitly demands proof for room air purifiers, but blindly trusts the method of free ventilation "despite all shortcomings" without proof, although the shortcomings of this method are completely evident. Unfortunately, the reasons for this attitude could not be clarified even in our Spiegel controversy [13].

Recommendation

It is easy to predict that the children, teenagers, teachers will not ventilate sufficiently during the cold season, as it will be very unpleasant. After all, airing is not only a question of ability, but also of will! To counter this understandable behavior without endangering the safety of the children, it is necessary to use transparent protective walls with a surrounding edge to minimize direct infection. In addition, the use of quiet room air cleaners that filter at least 6 times the volume of the room per hour and use a class H13 or H14 filter is highly recommended to counteract indirect infection. Therefore this protection concept should not be prevented in schools for ideological or other reasons. If a community or school management decides to implement this concept to protect children and workers, they should be free to do so. Anyone who prevents the implementation of this concept promotes the occurrence of infection and thus suffering and death. The list in the appendix illustrates the wide distribution of the protection concept in the world of work. It is time that not only adults provide for their own protection, but also that children are included, because children will have to pay for the enormous costs of the pandemic over the next decades. The promotion of a truly effective protection concept for schools not only increases safety, but also pays off in the long term, since a lockdown at schools can be prevented. This avoids considerable costs for the state, the economy, the health care system and society, and restores a degree of normality in schools.

Christian J. Kähler

Figure 1: Transparent protective walls in a classroom and room air cleaner.

Figure 2: Lateral discharge of aerosol particles with simple MN coverings and surgical masks.

References

[1] Hygieneplan für die bayerischen Schulen. https://www.km.bayern.de/ministerium/meldung/7061/aktualisierter-rahmen-hygieneplan-fuer-schulen-liegt-vor.html. 13.11.2020

[2] Kähler CJ, Fuchs T, Mutsch B, Hain R. Schulunterricht während der SARS-CoV-2 Pandemie – Welches Konzept ist sicher, realisierbar und ökologisch vertretbar? DOI: 10.13140/RG.2.2.11661.56802. 22.09.2020

[3] Curtius J, Granzin M, Schrod J. Testing mobile air purifiers in a school classroom: Reducing the airborne transmission risk for SARS-CoV-2. medRxiv 2020.10.02.20205633; doi: https://doi.org/10.1101/2020.10.02.20205633. 2020

[4] Kähler CJ, Fuchs T, Hain R. Können mobile Raumluftreiniger eine indirekte SARS- CoV-2 Infektionsgefahr durch Aerosole wirksam reduzieren? DOI: 10.13140/RG.2.2.27503.46243. 2020

[5] Kähler CJ, Hain R. Fundamental protective mechanisms of face masks against droplet infections. Journal of Aerosol Science 148:105617, https://doi.org/10.1016/j.jaerosci.2020.105617. 2020

[6] https://apps.who.int/iris/bitstream/handle/10665/333919/WHO-2019-nCoV-IPC_Masks-Children-2020.1-chi.pdf

[7] https://apps.who.int/iris/bitstream/handle/10665/335945/WHO-2019-nCoV-IPC_Masks-Children-2020.1-fre.pdf

[8] https://www.cdc.gov/coronavirus/2019-ncov/downloads/science-of-masking-abbreviated.pdf

[9] CORONA: From droplets to pandemic - how we can determine the spread of Covid-19. The Royal Netherlands Academy of Arts and Sciences. https://www.knaw.nl/en/news/calendar/corona-from-droplets-to-pandemic. 04.06.2020

[10] Richtig Lüften in Schulen. Umweltbundesamt. https://www.umweltbundesamt.de/richtig-luften-in-schulen#warum-ist-ein-regelmassiger-luftaustausch-in-klassenzimmern-wichtig. 15.10.2020

[11] Einsatz mobiler Luftreiniger als lüftungsunterstützende Maßnahme in Schulen während der SARS-CoV-2 Pandemie. Umweltbundesamt. https://www.km.bayern.de/download/23988_201116_irk_stellungnahme_luftreiniger.pdf. 16.10.2020

[12] https://www.umweltbundesamt.de/presse/pressemitteilungen/richtiges-lueften-reduziert-risiko-der-sars-cov-2, 13.08.2020

[13] Streitgespräch zu Corona-Strategien für Schulen. Filtern oder Lüften? Jens Radü, Spiegel Plus, 19.11.2020

[14] Heinz E. Wohnungslüftung – frei und ventilatorgestützt. Herausgeber DIN, Beuth Verlag, ISBN 978-410-25270-2, 2016

[15] Mobile Luftreiniger in Schulen: Nur im Ausnahmefall sinnvoll. Umweltbundesamt. https://www.umweltbundesamt.de/themen/mobile-luftreiniger-in-schulen-nur-im-ausnahmefall, 08.11.2020

Appendix: Organisations that have already procured air purifiers (selection)

Ministerium für Verbraucherschutz
Ministerium für Soziales, Gesundheit und Familien
Oberfinanzdirektion Karlsruhe und Stuttgart
Ministerium Baden Württemberg
Finanzgericht München
Bundesagentur für Arbeit
Katastrophenschutz in mehreren Bundesländern
Polizeischulen
Viele Land u. Amtsgerichte
Diverse Gemeinden in Deutschland
Zahlreiche Schulen und Universitäten
Johanniter Kliniken
Deutsche Diabetes Forschungsgesellschaft
Oberbergkliniken
Mehrere Covid Abstrichstationen
Malteser Hilfsdienst
Charité Berlin
Bayerisches Rote Kreuz
Deutsches Rotes Kreuz
Arbeiter Samariter Bund

Max Planck Gesellschaft
Fraunhofer ISC
Paul Ehrlich Institut
Leibniz Institut
DWI - Leibnitz Institut
Alfred Krupp Stiftung
Erdoelvorratsverband Porsche AG
VW AG
Wispo AG
Deutsche Bundesbank
Deutsche Bank
Sebapharma
Deutsche Welle

Bayerische rote Kreuz
Arbeiter Samariter Bund Augsburg
Constantin Film Gemeinde Oberhaching
Technische Hochschule Ulm
Infineon
MTU Aero Engines
Stadtwerke München
Best Bing Group
Bezirkskliniken Schwaben
Implenia Instandsetzung
freiwillige Feuerwehr Planegg
Klinikum rechts der Isar
Siemens Healthcare
Conrad Elektronik