



Hochschule
FÜR MUSIK
Freiburg



Risk Assessment of a Coronavirus Infection in the Field of Music

Seventh Update of September 13, 2021

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1 Short Summary

The present 7th update has been made as several parameters in assessing the pandemic situation in the months following the 6th update have changed.

On the one hand, this concerns the vaccination process. Since the lifting of prioritization on June 7, 2021, every adult person can be vaccinated. Access, which was initially limited, has turned into a surplus of vaccines since the end of July. Moreover, on August 16, 2021, the STIKO declared a general recommendation for the vaccination of 12- to 17-year-olds

(https://www.rki.de/DE/Content/Kommissionen/STIKO/Empfehlungen/PM_2021-08-16.html).

On the other hand, new regulations and ordinances were passed by the federal government and the individual states (cf. p. 5 ff.).

Due to a high vaccination rate, it is now possible to reassess the risk for musicians based on a review using the rules for those vaccinated and those recovered (in German, the so-called 2 G Rule, the “Geimpfte und Genese”).

As the risk assessments to date of our working group have shown, the **guiding principles** of this current risk assessment are also: 1. that the **risks of a coronavirus infection** in the field of music **be specifically named and detailed**, and 2. that **specific measures**, both individually and in combination, be recommended that appear suitable for **reducing the risk of becoming infected**. The **risk assessment** is also intended to **help define the basic conditions during the pandemic** under which **singing and playing music** can take place with the **greatest possible reduction of risk**. The present assessment is based on **scientific findings** on the subject, including our own research studies, the recommendations of experts, and information in the available literature, some of which is listed in a detailed bibliography below (cf. p. 69 ff.).

Two key pathways of infection transmission are still assumed to be:

1.) contact transmission and 2.) airborne transmission (cf. p. 20 ff.).

To **reduce risk, four lines of action** are suggested: 1.) entrance screening, 2.) regulating the parameters of air flow/room size/length of exposure/group size, 3.) individual protective measures as well as 4.) vaccination (cf. p. 23 ff.).

The risk assessment is written specifically for various forms of singing and different wind instruments as well as for other groups of instruments such as string and keyboard instruments, both for individual lessons and for various group settings. It has been drawn up for both the professional and amateur sectors of music making.

The central component of the risk assessment is the **risk management, which describes four levels of risk reduction** (cf. p. 65 ff.). **By observing the measures proposed in that for reducing the risk – particularly taking into account the so-called 2 G Rule (see p. 3) – it appears that, according to what is known at present, active singing and music making will become more possible in the coming months of the pandemic that has yet to be overcome.**

2 Current status of the social discussion and updated Corona regulations

Since the publication of the 1st risk assessment by the authors on April 25, 2020, new questions have repeatedly been raised, precipitated by the ever-changing rate of infection. The circumstances of the Corona pandemic continue to remain highly fluid. The lockdown, which has been deployed in various forms around the world since November 2020 (since November 2, 2020, in Germany), affected the cultural sector and its musical activities especially hard. Organized forms of singing and playing in the field of amateur music and in schools, as well as the professional performance of music by orchestras, choirs, bands and ensembles in theaters, concert halls, opera houses and other venues were not permitted and are in part still subject to extensive restrictions.

The vaccination rates offer useful information on potential infection risks. According to RKI data, up until September 7, 2021, 66% of the population had been vaccinated at least once, and 62% had been fully vaccinated.

(https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Situationsberichte/Wochenbericht/Wochenbericht_2021-09-09.pdf?_blob=publicationFile).

Vaccination rates and general attitudes toward vaccination in the cultural sector / field of music in June/July 2021 were investigated in a study by our own working group (Spahn et al. 2021). In total, 4,341 persons from four different areas took part in this study. Those in the four areas included visitors to / audiences of classical concerts and musicals, professional musicians, and participants in amateur music-making. The results showed a vaccination rate of 86% for with the first vaccination, and 54.5% for those fully vaccinated. The vaccination rates at the time of the investigation were distinctly higher when compared with the overall population. The number of those still hesitant about receiving a vaccination (3.3%) or refusing a vaccination (3.1%) was only around half as much as the general population. As the data was gathered in June/July 2021, it can be assumed that those who had received the first vaccination have also had the second one, and so more than 90% of those questioned in the sample test have full vaccination protection. The results of this sample test can serve as indication of the fact

that a high degree of willingness to be vaccinated and a low level of refusal seems to exist in the cultural sector of music.

Since the beginning of the corona pandemic, extensive findings and experience have been gathered in the sciences and through practical musical experience that have been incorporated into the hygiene concepts of the respective music settings and music institutions.

In principle, the nationwide German regulations and those in the individual German federal states (gatherings, contacts, minimum distancing and Mouth-Nose-Protection), which were defined by the responsible ministries and coordinated with the health authorities (as well as any other applicable authorities and the statutory accident insurance providers), apply to all musicians. The countrywide emergency brake initially valid on April 23, 2021, starting from an incidence rate of more than 100 per 100,000 inhabitants, was suspended on June 30, 2021. It was not prolonged on account of the low incidence rate. However, it cannot be ruled out that, depending on the vaccinate rate and infection figures, similar regulations are implemented. At both the federal and state (provincial) level, it was agreed on August 10, 2021 to align the Corona restrictions. Above all, those persons vaccinated or fully recovered from the disease are exempt from the majority of restrictions. As Germany is organized in a federal structure, it is not possible within the confines of this risk assessment, to outline the Corona regulations of all 16 states in detail. For this reason, we have mostly drawn upon the situation in Baden-Württemberg as an example in the following text.

(<https://www.baden-wuerttemberg.de/de/service/aktuelle-infos-zu-corona/faq-corona-verordnung/>) The regulation currently valid in Baden-Württemberg from August 14, 2021, unlike previous such regulations, is not based exclusively on the incidence data, rather measures were formulated “taking into account the strain on the health system (occupancy rate of intensive care beds, AIB in German), the seven-day incidence rate, the vaccination coverage and the number of severe disease outcomes (hospitalizations)”. One innovation in this current Corona regulation is that the minimal distances, while generally recommended, did not have to be observed mandatorily, in so far as the space available does not make this possible.

Currently – as of September 9, 2021 – a new version of the Infection Protection Law has been developed by the Federal Parliament (Bundestag) and passed by the Federal Assembly (Bundesrat), on the basis of which the federal states will once again align their Corona regulations. For example, the future Corona regulation for the State of Baden-Württemberg, which is expected to become law as of September 15, 2021, allows for a two-step warning system, which is no longer linked to the incidence rate, but rather to hospitalizations. In the first step – which will become effect as soon as 250 intensive ward beds in Baden-Württemberg are filled with Covid-19 patients, or the hospitalization incidence of eight is reached or exceeded – the so-called 3 G Rule (recovered, vaccinated, tested) is planned based on PCR tests. In the second step – the alarm step that is triggered in the event that 390 Covid patients on intensive care wards are treated, or if the hospitalization incidence of twelve is reached or exceeded – then the so-called 2 G Rule (recovered, vaccinated) is implemented.

Concerning practicing musicians, the Administration Professions Cooperative (VBG) also aligned its stipulations in July 2021 to the current situation; these rules apply to professional musicians in ensembles who are insured with the VBG

https://www.vbg.de/DE/3_Praevention_und_Arbeitshilfen/3_Aktuelles_und_Seminare/6_Aktuelles/Coronavirus/Brancheninfos_Arbeitsschutzstandard/Buehnenstudios_Probenbetrieb.pdf?__blob=publicationFile&v=30.

This can serve as a reference point for the amateur music sector. The exact wording found in the current edition of the “Branch-specific practical guide for the SARS-CoV-2 Work Protection Standard – for the stage and studio sector” is as follows: “Vaccination against SARS-CoV 2 is the most effective preventive measure and the most important measure on the road back to greater operational normality. Severe, and in particular lengthy, courses of the disease, as increasingly seen, can be effectively avoided in this way. [...] In the case of fully vaccinated and recovered persons, the risk of infection is distinctly reduced, though this is not a so-called sterile immunity. It must be assumed that some people, having been exposed to SARS-CoV2, may be tested positively with PCR despite vaccination or recovery, and may potentially pass the virus on, too. It is

permitted to waive the so-called (in German) AHA+L measures (keep one's distance, observe hygiene rules, wear mask in daily life, increase ventilation), provided the risk of transmitting the virus is slight. This is the case in general if all employees have been fully vaccinated or have recovered from the virus [...]. One should waive the AHA+L measures only in case of operational necessity, provided all persons working in a work area at the same time have been fully vaccinated or have fully recovered from the virus. For example, it is possible to dispense with the AHA+L measures for the rehearsals and performances of a fully vaccinated choir, which plans to sing with social distancing and the wearing of masks. If, however, the whole group of singers is not fully vaccinated or recovered, then the requirements in the remaining sections of this practical guide continue to apply.”

According to the current Corona regulations effective in Hamburg of August 27, 2021 (<https://www.hamburg.de/verordnung/>), organizers of events can already proceed with a 2 G Access Model (exclusively those vaccinated and recovered, with the relevant proof). The social distance regulation has been lifted as part of this 2 G Rule.

The 2 G Rule is being implemented in the realm of professional sports in Germany, too. For example, FC Cologne already announced the use of the 2 G restriction at the beginning of the Federal Football League (Bundesliga) season. Likewise, at VfL Wolfsburg, only those recovered from the virus and those vaccinated are permitted to enter the stadiums, with effect from September 2, 2021.

Discussions as to the appropriate social policy for those vaccinated and recovered from the virus is being held throughout the world. In some countries with a high inoculation rate in the general population, such as Great Britain or Denmark, nearly all restrictions have been lifted.

In German politics, too, thought is being given to the normalization of daily life for persons who have been vaccinated or have recovered from the virus.

Regarding the possibility of breakthrough infections, studies have shown that in individual cases, infections, so-called breakthrough infections (Birhane et al. 2021) can occur, despite full vaccination. The term “breakthrough” is misleading, however, as it

suggests that infections can arise despite a good response on the part of the immune system. However, it may be assumed that the immunization of the person concerned through the vaccination was insufficient, as can happen with older people, for example. On the basis of the data available to date, the assumption is that the viral excretion in those persons who have become infected with SARS-CoV-2 after a complete series of vaccinations is greatly reduced following the said vaccination, and thus the risk of transmission is reduced. Breakthrough infections mostly proceed in an asymptomatic or mild manner (Antonelli et al. 2021). As the Freiburg virologist Hartmut Hengel explained in an interview in the *Badische Zeitung*, regarding those fully vaccinated, we speak in Germany “of protection from symptomatic infection, which lies between 80 and 90 percent, and in the case of severe infections, even above that. That explains why those lying on intensive care wards are almost exclusively unvaccinated persons” (“Infections following vaccination are rare” BZ, 02.09.2021).

2.1 Music universities taking the Freiburg University of Music as an example

Voice and instrumental lessons at music conservatories, public and private music schools and other educational institutions are of special significance. Since the beginning of the winter semester 2020/21 we have gathered experiential data at our own Freiburg University of Music pertaining to the implementation of the risk-reducing measures presented in this risk assessment. As the conservatoires in Baden-Württemberg have continued to allow in-person teaching for individual music lessons and for ensemble and chamber music groups, it can be stated in summary for the Freiburg University of Music – for which we have detailed data – that the presence of students and teachers (who subsequently tested positive as asymptomatic contact persons and had previously attended courses at the music conservatory) did not lead to the further spread of the coronavirus infection within the music conservatory. It can be deduced from this that our empirically verified ventilation measures plus compliance with the specific instrumental and singing-specific distancing, masking, and hand and

contact surface cleaning rules can obviously prevent a coronavirus infection. It should be emphasized here that this also applied to settings at the HfM Freiburg in which people sang (Solfège group lessons, choral ensemble rehearsals, singing lessons). By way of contrast, in the case of another teaching institution in which the distancing, ventilating, and masking rules, as well as a reduction in rehearsal duration, were not observed, the same situation – singing in groups – led to an increased infection rate among those involved.

With the exception of the first lockdown in April 2020, the Freiburg University of Music (HfM) has been able to offer in-class teaching of the arts almost continuously. Students had access to the university building and were able to continue practicing. Large ensemble activities (choir and orchestra) were restricted; however, these could resume in the winter semester of 2021/21, and increasingly so in the summer semester of 2021, subject to compliance with hygiene measures. From the beginning of the 2021 summer semester, the HfM principal's office set great store on achieving the highest possible vaccination coverage for status groups within the music university setting. Information events on this were held and specific vaccination offers were made to both students and employees of the university.

From June 23 to July 5, 2021, a survey was carried out by the FIM with the goal of determining the vaccination rate among HfM Freiburg staff, and of being able to assess the protection by vaccination for the winter semester of 2021/22.

Students, teaching staff and members of the administration and technical support were invited by email to fill in voluntarily an anonymous online questionnaire. Letters were sent out in various languages – German, English, French, Spanish, Italian and Chinese. A positive vote was passed by the Ethics Committee of the Freiburg University Hospital in favor of the implementation and evaluation of the survey, especially with regard to compliance with data protection.

In total, 786 persons took part in the questionnaire. This corresponds to a participation rate of 87% of the overall staff numbering 909 persons. Among the 786 participants, 47% are female, 52% are male, and 1% diverse.

81.1% of the sample were recovered or vaccinated (33.1% with full vaccination protection, 42% vaccinated once), 3.8% reject vaccination, and 4.1% are still undecided.

If those persons already vaccinated are combined with those wishing to be vaccinated, then a percentage of 92% can be calculated for those fully vaccinated in the winter semester of 2021/22. Nonetheless, this figure will only remain realistic provided a correspondingly high number of newly enrolled students have already been vaccinated.

According to the current Corona regulation for studying in the state of Baden-Württemberg of August 23, 2021 (<https://www.baden-wuerttemberg.de/de/service/-aktuelle-infos-zu-corona/uebersicht-corona-verordnungen/coronavo-studienbetrieb-und-kunst/>), on-campus learning is permitted once again for the winter semester. “In accordance with this regulation, on-campus studying at institutes of higher education is permitted; this is supplemented by studying in digital formats as well as other distance learning formats. Events with live attendance by participants and other actual attendance formats for studying, as well as student learning, working and practicing areas (student learning spaces) require the authorization of the principal’s office or the academic management, in accordance with this regulation. Authorization is to be granted in line with prudent judgment.”

2.2 Amateur Music-Making

Until the partial lockdown at the beginning of November 2020, amateur music was still being played and sung – especially among brass ensembles and choirs. Both amateur music organizations and academies have been very exact in implementing the recommended measures into their hygiene concepts. To advise the respective

ensembles, choirs, musicians, and conductors, the State Ministry of Science, Research and Art in Baden-Württemberg set up an advice center at the FIM beginning July 2020 for the field of amateur music (<https://fim.mhfreiburg.de/beratung-amateurmusik/>). For this reason, a working collaboration also exists with the Musikakademie Staufen. In October 2020, measurements of indoor air were carried out there during rehearsals of larger ensembles and specific ventilation measures were developed for these situations (Nusseck et al. 2021).

As amateur music activities had been suspended since the beginning of November 2020, the FIM team produced film and sound recordings in December 2020 to sing along with at home so as to give choral singers a positive boost through to the other side of the “singing break”. The recordings are accessible to the public on the FIM homepage. (<https://fim.mh-freiburg.de/beratung-amateurmusik/singeuebungen/>).

A study (Cho-Co-Studie) by the Catholic University of Eichstätt-Ingolstadt from May 2021, in which more than 4,300 choirs from German-speaking countries participated (Schlemmer et al. 2021), shows that the situation for numerous choirs (especially children's and youth choirs) is difficult, both financially and in terms of dwindling membership numbers. More than half of the choirs answered in the negative range regarding both the musical and mental state of their members.

A survey by the German Music Council, which was based on both qualitative surveys of 39 key persons in Germany's musical life and an online survey with 2,851 evaluable data sets in the period from March 2020 to February 2021, shows similar tendencies (Betzler et al. 2021). In addition to questions about changes to income in the Corona year and the use and evaluation of Corona aid offers, questions are also addressed here regarding problems affecting up and coming talent, the erosion of amateur music's existence and the damage to music's image.

This deficit is being addressed by political decision-makers, too. In the current regulations covering art and culture in the state of Baden-Württemberg (as of 25.08.21), it is clear that under the new Corona regulation, the same easing of restrictions benefits amateur music-making as it does professional musicians (<https://mwk.baden->

[wuerttemberg.de/de/service/informationen-zu-corona/corona-verordnung-studienbetrieb/faq-kulturbetrieb/](https://mwk.baden-wuerttemberg.de/de/service/informationen-zu-corona/corona-verordnung-studienbetrieb/faq-kulturbetrieb/).

2.3 Audience

In the current Corona regulation of the state of Baden-Württemberg there are also only a few restrictions with regard to audiences, too. (Comments on the current regulations for art and culture, as of 25.08.21, <https://mwk.baden-wuerttemberg.de/de/service/informationen-zu-corona/corona-verordnung-studienbetrieb/faq-kulturbetrieb/>).

“All cultural events are permitted. Audience capacity may in essence be fully utilized. Events that exceed in number 5,000 attendees are only permitted up to 50 percent of the permitted capacity, up to a maximum of 25,000 persons.” Minimum social distancing can be dispensed with, provided the persons concerned are vaccinated, recovered (from the virus) or tested, and observe the face mask stipulation. “When the hygiene concept of a given event ensures that exclusively immunized and tested persons have access to it and that mandatory face covering in accordance with § 3 of the Corona regulation is strictly observed, then, in the case of events with up to 5,000 persons, the full capacity of attendees can be utilized, even if this means falling short of the recommended minimum distance of 1.5 meters.” “Within enclosed spaces a medical mask must be worn as a matter of principle (also when seated).” (Comments on the current regulations for art and culture, as of 25.08.21, Paragraph 3 and Paragraph 5, <https://mwk.baden-wuerttemberg.de/de/service/informationen-zu-corona/corona-verordnung-studienbetrieb/faq-kulturbetrieb/>).

Concerning the regulations in other German federal states and provinces, the respective Corona regulations in force there are to be observed.

There were reports on observational studies from Halle (RESTART-19) and from the Bavarian State Opera (Bayerische Staatsoper December 3, 2020) in 2020 already. Both projects emphasized the importance of adapting hygiene plans to the respective performance locations and that precise information on ventilation and filtering technology, on distancing regulations and compliance with them, and on masking issues (mouth and nose protection) is essential.

Another pilot study took place in Barcelona at the end of March 2021. 5,000 people attended a rock concert there without maintaining safe distancing. All attendees were tested on the same morning in three test centers using (CoVid2) antigen tests. Only those with a negative test result were allowed to attend the concert. In addition, they all wore FFP2(N95) masks and were in Palau Sant Jordi (arena capacity up to 24,000 spectators) where a particularly powerful ventilation system had been installed. 14 days after the event, the attendees were tested again. Six attendees had a positive result (which corresponds to an incidence value that is lower than at the time in Barcelona), four of them had been shown to have been infected elsewhere. In retrospect, it can thus no longer be referred to as a super-spreading event (Revello et al. 2021).

Cultural events in Austria have also been allowed to reopen as of May 19, 2021 (Bundesgesetzblatt für die Republik Österreich – 1. Novelle zur COVID-19-Öffnungsverordnung). Here, only those that belong to the so-called 3 G group – those who have either been vaccinated, have recovered, or have tested negative – will be allowed to enter (cf. <https://www.sozialministerium.at/Informationen-zum-Coronavirus/Coronavirus---Aktuelle-Maßnahmen.html>). In addition, wearing an FFP2 mask is required during the entire cultural event. These opening-up steps in Austria not only affect the cultural sector, but the restaurant sector, as well.

For example, at this year's Salzburg Festival, the venues' capacity could be fully utilized as all members of the audience wore FFP2 masks. Two weeks after the end of the Salzburg Festival, no outbreaks of the infection are known of to date.

The Kammermusiksaal at the Berlin Philharmonic is also fully utilized at present, for which reason an FFP2 mask must be worn throughout the entire concert.

At the Berliner Ensemble, full capacity will be possible again from September onwards, albeit also in combination with mandatory face covering.

For the Pierre Boulez Saal, the concert hall at the Barenboim Academy in Berlin, a further step has been taken. All seats are on offer and, moreover, it is permitted to take off one's mask when seated. The 3 G Rule still applies here.

The case is different at the Berliner Oper. As the regular audience at the Komische Oper decided in a survey in favor of a chessboard-style seating plan, without the wearing of masks, the auditorium will be utilized with only 50% capacity until the end of September. Something similar applies to the Berliner Staatsoper Unter den Linden. There, the audience is permitted to sit at one meter's distance from one another, and one is recommended – though not obliged – to wear a mask.

The examples listed here show that the present practice of visitors' regulations is handled differently, depending not only on the federal state concerned, but also the specific venue.

2.4 Experts' Recommendations

Meanwhile, further scientific studies and technical discussions among experts have emerged. Here we would especially like to refer to the statements released on December 3, 2020, and March 24, 2021, by the appointed interdisciplinary "Expert Group Aerosols" set up by the state government of Baden-Württemberg, whose texts we were involved in formulating

https://www.baden-wuerttemberg.de/fileadmin/redaktion/m-mwk/intern/dateien/Anlagen_PM/20201204_Stellungnahme_Aerosole_SARS_CoV2.pdf

as well as https://www.baden-wuerttemberg.de/fileadmin/redaktion/m-mwk/intern/dateien/pdf/Expertenkreis_Aerosole_-_2._Stellungnahme_02.pdf.

Other risk assessments pertaining to musicians and singers are currently available from various sources in Germany, including from the Charité (Mürbe et al. 2020a as well as Willich, et al. 2020), the DGfMM (Firle et al. 2020), from Kähler & Hain, as well as from the Arbeitskreis Gesundheit und Prophylaxe der Deutschen Orchestervereinigung (DOV) with commentary by the Verband Deutscher Betriebs- und Werkärzte VDBW AG Bühnen und Orchester (Böckelmann et al. 2020).

A part of our risk assessment is the result of the medical examination of wind players and singers by various (*German ENT*) working groups (Becher et al. 2020; Echternach et al. 2020; Spahn et. al; Nusseck et al. 2020; Richter et al. 2020; Kähler & Hain et al. 2020 a/b; Mürbe et al. 2020).

Our own working group was involved in tests that were initiated by the Bamberg Symphony Orchestra and carried out on May 5, 2020 (Spahn et al. 2020; Richter et al. 2020), as well as in the presentation of the scientific results of the working group of the Bauhaus University (Becher et al. 2020 c). We were also able to take measurements of the CO₂ concentration at the Freiburg University of Music and at the Staufen Music Academy (Spahn et al. 2020) (Nusseck et al. 2021).

In those areas in which no peer-reviewed scientific data is yet available, these comments will continue to represent the informed professional assessments of the authors. The paper presented here is therefore still a snapshot in time, to be reviewed and adapted in light of new scientific evidence in the future, taking the latest status of existing governmental regulations into account.

As authors, we are striving to include scientific results in our assessment that are as comprehensive and as up to date as possible. The aim is to continually adapt the risk assessments already made so that they are in line with the latest scientific knowledge, and thus facilitate consensus. To this end, we regularly publish the latest scientific findings and risk-reducing measures in numbered and dated updates of our risk assessment. The latest version is posted under the same link on the homepage of the Freiburg University of Music.

In order to increase the quality and reliability of the risk assessment at hand, we established an interdisciplinary working group at the University Hospital Freiburg with colleagues from the Institute for Infection Prevention and Hospital Hygiene (Director, Prof. Dr. med. H. Grundmann), Prof. Dr. med. Hartmut Hengel, (Chief Medical Director of the Institute of Virology) and Prof. Dr. med. Hartmut Bürkle, (Chief Medical Director of the Clinic for Anesthesiology and Intensive Care Medicine).

2.5 Risk management as central approach

Since the outbreak of the Coronavirus pandemic, we have all gained an increased understanding of the epidemiologically important factors in the spread of SARS-CoV-2. From the start, the Robert Koch-Institute and politics in Germany have made it clear that the aim of the instituted protective measures is to slow down and contain the spread of infection. The guiding principle of these measures is to reduce the risk of infection with SARS-CoV-2 as much as possible.

In our view, a risk assessment focused on specific questions of music practice should therefore be based on the *added* risk that arises therefrom. This focus on existing general standards is important to us in that it enables political decision-makers to evolve appropriate recommendations for action in the field of music.

The risk assessment presented here pursues the concept of risk management with the aim of identifying specific risks in the field of music while offering risk reducing measures at the same time. In this way risk management concepts and their related questions, which are adapted to meet specific musicians and musical situations, can be appropriately and flexibly integrated into the society as a whole.

In furthering a flexible risk adaptation, one might make a stronger differentiation in the future between infection risk and disease risk, and to take different precautionary measures depending on the susceptibility of the musicians (previous illnesses, age, etc.). The local and time-dependent epidemiological situation (e.g., in a city or local community) could also be considered when devising strategies to prevent infections when playing or singing together. For example, the collective risk of a choir rehearsal can be better assessed using a CORONA WARN APP – which has been online since June 16, 2020 – or the LUCA app. Comprehensive tests could also make an important contribution.

Comprehensive tests, too, could make an important contribution to this – in particular for children and youths, for whom there is no vaccination on offer – in schools, for example.

Since the lifting of prioritization on June 7, 2021, vaccination has become the central plank in risk prevention, as in the meanwhile the offer of vaccination exists, and is recommended, for all adults in Germany, and for youths aged 12 upwards, as well.

2.6 Long term effects -- psychosocial after-effects

The longer the corona pandemic and its imposed accompanying measures continue, the more negative psychosocial after-effects are being observed. These affect those musicians the most directly who are existentially threatened economically. Additionally, many musicians also fear for the future. And all those whose social contacts and *joie de vivre* lie in making music together – yet do not depend on making a living from music and are financially secure – often still feel alone and depressed. Our students' mental health is particularly crucial, especially for those young musicians who will shape our musical culture in the future. Supported by effective hygiene concepts, we want to be able to offer them in-person teaching with lively artistic experiences, even in times of a corona pandemic. This section has been included in the risk assessment because psychological issues – in addition to its threatening economic aspects – are becoming increasingly important in the field of music making.

Dealing with the consequences of the pandemic leads to a stress syndrome that is especially triggered and intensified by unpredictability, helplessness, and a feeling of being at the mercy of people (Heitzmann 2020; Petzold et al. 2020). Two reviews (Brooks et al. 2020; Röhr et al. 2020) consistently describe the psychosocial aftereffects of quarantine measures, including depression, anxiety, anger, stress, post-traumatic stress, social isolation, loneliness, and stigmatization. Information about significant factors influencing the psychological well-being in the German general population during the corona pandemic is given in a study by Kühner et al. 2020. Here, a random sample from the population (n = 721) was quizzed in writing about their own estimations, aspects of personality and current psychological well-being relating to the Coronavirus. It showed that several factors played a role in their psychological well-being. Negative effects were fear for the health of loved ones, stress from restrictions on

going out, increased substance consumption, as well as psychological risk factors, whereas resilience factors formed important resources for dealing with the pandemic.

Singing and playing music represent extremely important psychological resources. This applies not only to professional musicians – be it in their studies or at work – but also to the many people for whom making music is a central and social focus of life. It is therefore imperative for our society to organize singing and playing music in a responsible and social manner, while still complying with Corona restrictions, so that infection risks can be largely reduced, and resources can be fully exploited.

Even though more will become slowly possible again from an infectiological viewpoint, it is difficult for many people to reconnect with life before Corona. Singing in particular has been labeled as dangerous and this obstacle needs to be overcome first. That singing and making music is highly positive and important for one's mental health must be re-established as the threat from Corona diminishes. The promotion of children and youths in singing and music-making is an especially important undertaking, carrying moral responsibility.

3. Excursion Transmission pathways of SARS-CoV-2

3.1 Basic Information

The main avenue of transmission of viruses that cause respiratory infections generally takes place via **aerosols**. This occurs when exposure to coughing and sneezing leads to the inhalation of aerosols by a person through the mucous membranes of the nose, mouth, and deep respiratory tract, and possibly through contact with the conjunctiva of the eye. An aerosol (an artificial word formed from ancient Greek *αήρ*, English “air” and Latin *solutio* “solution”) is a heterogeneous mixture of very small, solid, or fluid particles suspended in a gas. In this context, **droplets** are to be understood as larger particles (diameter of more than 5 micrometers). In some cases, they can be so large that they are visible when a person coughs or sneezes and can be felt on the skin. A portion of the droplets fall to the ground within 1 meter proximity due to gravity. Another portion of the droplets evaporates – depending on their size, composition, and the condition of the surrounding air (saturation). What remains are the finest droplet nuclei, that quickly spread about their source and within (confined) spaces. A Finnish working group, centered around Ville Vuorinen from Aalto University in Helsinki, carried out a computer simulation of the spread of aerosols in a closed room/supermarket (Vuorinen et al. 2020 a/b). According to the simulation if an infected person sheds virus when coughing, the viruses can still be detected in the air after several minutes, even if the sick person has already left the room. Other people can then inhale the airborne viruses. SARS-CoV-2 can remain viable in aerosols several hours long (van Doremalen et al. 2020). The lower the temperature and the lower the humidity, the longer aerosols can remain in a confined space and on surfaces.

Viruses can also be transmitted via surfaces when others touch these contaminated surfaces with their hands and then touch their faces before washing their hands – provided the virus particles are still infectious at this point (**contact transmission**).

Asymptomatic individuals emit mostly aerosols <10µm and produce very few droplets. Aerosols are more concentrated nearer the emitter. When aerosols escape from the mouth opening, it is to be expected that they will initially rise due to their lower specific

density (approx. 37 °C and > 95% relative humidity) and then mix with the room air. The sedimentation of aerosol particles smaller than approx. 4 µm, no longer play a significant role. Thus, aerosols in closed rooms initially collect on the ceiling of the room. In the further course of time, they are distributed – like a gas – throughout the entire room. In terms of exposure, a distinction is therefore made between direct exposure in the near field (distance < 1.5 m) from the increasing concentration of aerosols in the room air.

It is not yet known how many infectious aerosols or droplets are necessary to cause an infection. The viral load necessary to cause an infection is even less known.

The transmission pathways are shown schematically in Figure 1 below.

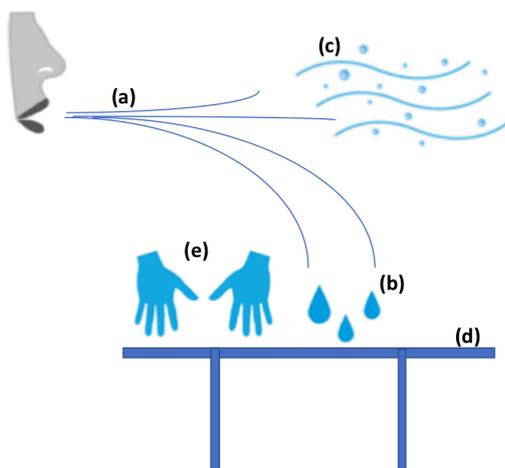


Fig. 1: Schematic representation of the possible transmission pathways. With exhaled air (a), droplets (b) and aerosols (c) are released into the environment. The droplets can land on surfaces, e.g., a table (d). From there they can be picked up by hands (e). If the hands come into contact with the mouth, nose, or eye, a contact transmission (smear infection) can occur.

3.2 Specific information regarding SARS-CoV-2

According to the current state of knowledge, the spread of the corona virus (scientific name: SARS-CoV-2) can be given as the cause of the COVID-19 disease, which is transmitted via the pathways of droplet or aerosol infection (Meselson et al. 2020).

According to data in three studies from the Robert Koch-Institute from April 17, 2020, aerosols containing coronavirus RNA were detected in air samples of the exhaled breath of patients or in the room air inside patient rooms (Leung et al. 2020; Chia et al. 2020; Santarpia et al. 2020).

Currently more importance is attached to the transmission route via aerosols (Morawska & Cao 2020; Miller et al. 2020; Morawska & Milton 2020).

Contact transmission of the virus is also possible. Transmission through contaminated surfaces cannot be ruled out, especially in the immediate vicinity of the infected person (ECDC 2020) since reproductive SARS-CoV-2 pathogens can be detected in the environment under certain circumstances (van Doremalen et al. 2020). To what extent an infection via the eyes is likely, cannot as yet be conclusively determined here (Zhou et al. 2020).

In addition to the air we breathe, saliva and respiratory secretions should also be mentioned as other relevant infectious materials. In direct patient care, it was found that an above-average number of ear, nose, and throat doctors and anesthesiologists/intensive care physicians and nurses suffer from COVID-19. This is because they carry out endoscopic examinations and interventions in the mouth and throat area and may therefore have had intensive contact with all these three forms of transmission (Dt. HNO-Gesellschaft 2020; Ruthberg et al. 2020).

Each pathogen is assigned a so-called basic reproduction factor R_0 , which in the case of SARS CoV-2 was specified as 3.3-3.8. Variants created by mutations now appear to have higher values. This is important in achieving herd immunity. The higher R_0 is, the more individuals need to be immunized for this reason.

4 Systemic possibilities of risk reduction in the field of music

The vaccine against Coronavirus represents the most effective measure available, particularly in the music business. Although the opportunity currently exists to prevent a SARS-CoV-2 infection, and so falling ill with COVID-19, by means of vaccination, what follows still lays out other systematic possibilities of reducing risk. We do this especially because one important group in making music – children and youths – could not be covered as yet by vaccination, or at least only partially.

General systemic methods of risk reduction should first be established before a vocal, instrumental, and situational specific risk assessment can take place, which will be applicable to the field of music. In our view, these continue to play an especially decisive role for larger ensembles such as choirs, community singing, orchestras, and big bands. The following Figure 2 gives an overview of possible risk reduction measures. We find it practical to divide these risk reduction measures into four areas:

Entrance screening (including testing)

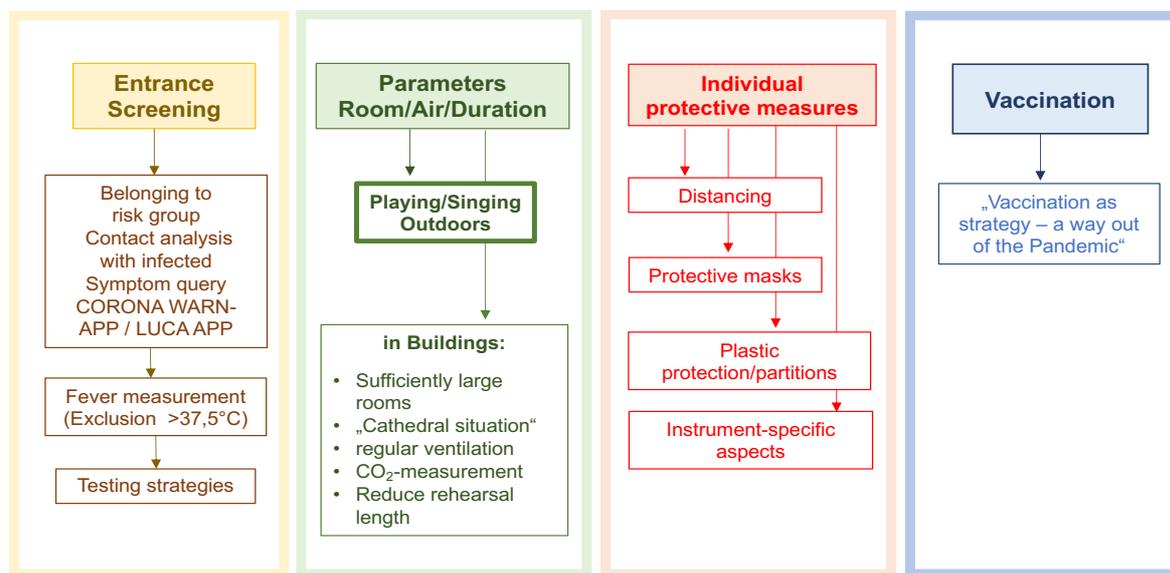
Air & Ventilation / Room & Space / Duration parameters

Individual protective measures

Vaccination

The areas of *entrance screening*, *individual protective measures*, and *vaccination* are assigned to the field of behavioral prevention, while the area of *Air & Ventilation / Room & Space / Duration parameters* is assigned to the field of situational prevention.

SYSTEMATIC POSSIBILITIES OF RISK REDUCTION IN THE FIELD OF MUSIC



Spahn/Richter, 2021

Figure 2: Overview over systematic measures of risk reduction in the field of music.

4.1 Entrance Screening

Entrance screening can include a survey and a comprehensive assessment of several relevant characteristics for the disease:

The assessment of carrier risk can be ascertained through a standardized screening (questionnaire or App¹) of personal contact analysis of the previous 5–6 days and of suspected COVID-19 symptoms. This standardized survey can serve to regulate eligibility for attendance at rehearsals / lessons / concerts and lead to better self-protection and the third-party protection in the future. The standardized survey is also part of the screening protocol for elective outpatient procedures currently in use at the

¹ Questionnaires and APP could be modeled on the screening tools in use at the University Hospital Freiburg since May 4, 2020.

University Medical Center Freiburg – which are also used at our FMI outpatient clinic. These simple measures are practical, efficient, and very well received.

The CORONA WARN-APP has also been available in Germany since June 2020 and, since March 2021, the LUCA-APP as well, each of which has a comparable function for determining contact risk.

A higher health risk can be assessed utilizing the RKI list of pre-existing conditions (RKI list of risk groups for severe disease progression²). Particularly strict precautions apply to older persons or persons at risk due to pre-existing conditions (see RKI risk list) who actively practice and perform music.

The parameter of age appears worth a closer look based on the statistics presented in Germany since the beginning of March 2020, whose numbers now represent a period of some eighteen months. Statistical information on deaths from COVID-19 shows that older people (>70 years) are significantly more affected than younger people (Statista 2020). Since the first death – which was reported on March 9, 2020 – (as of September 2, 2021) a total of 92,256 persons have so far died in connection with COVID-19 in Germany. Of these, 15 fatalities were observed to be in the first decade of life (0-9 years old), 11 fatalities in the second decade of life (10-19 years old), 88 fatalities were in the third decade of life (20-29 years old) and 248 fatalities were in the fourth decade of life (30-39 years old). The median age showed a distribution curve distinctly skewed to the right with a maximum in the ninth decade of life (80-89 years old) of 40,846 cases. With the exception of the children in the first ten years of life (11 female, 4 male), the number of deaths in all cohorts were higher among the male sex than the female.

An update of this information can be found at:

<https://de.statista.com/statistik/daten/studie/1104173/umfrage/todesfaelle-aufgrund-des-coronavirus-in-deutschland-nach-geschlecht/>

² Elderly persons (50 and older with ever increasing risk of severe disease progression), morbidly obese individuals, previously diagnosed cardiovascular disease, chronic lung disease, chronic liver disease, patients with Diabetes mellitus, patients with cancer, patients with compromised immune systems.

The information on two deaths in a choir in Skagit County, Washington (Hamner et al. 2020) also fits this age distribution (see detailed information on p. 48). Here, the median age of all the choir singers was 69 years, as was the median age of those who became ill.

Musicians in all areas of music should pay strict attention to symptoms of general illness such as fever with respiratory complaints (dry cough, catarrh) or, in the case of more typical COVID-19 symptoms, such as the acute loss of smell and taste, by avoiding any contact with other musicians until a SARS-CoV-2 PCR nasopharyngeal smear test has ruled out an infection.

In the event of a confirmed infection, entry from another country or area of high Corona risk, or contact with a person infected with the coronavirus, the most current quarantine rules must be observed. If symptoms occur, persons should contact their family physician without fail. In the case of music lessons for children and adolescents, legal guardians should also be given clear instructions to keep their children at home at the first suspected sign of Coronavirus or any other mild symptoms. University students should also be made aware of this protocol. Of course, this also applies to educators, who should not teach under these circumstances.

Another possible measure, which is relatively inexpensive and practical, is a system of temperature checks as an additional screening tool before making music with others. At the University Medical Center Freiburg, a majority of COVID-19 sufferers showed an elevated temperature in connection with acute respiratory complaints. The Robert Koch Institute, on the other hand, no longer recommends using temperature measurement as a screening method for entry points, e.g., at airports, as only 42% of those infected in Germany had an elevated temperature ($>37.5^{\circ}$ Celsius) (Epidemiological Bulletin RKI 20/2020). Asymptomatic, fever-free virus carriers who are actively shedding virus cannot be identified using temperature checks. Both a standardized survey and temperature check could improve the musicians' awareness of risks and increase the compliance of utilizing protective measures.

According to the stipulations of the National Testing Strategy, *testing* is an essential component of a comprehensive pandemic response: it is the basis for the timely detection and treatment of infections, for the interruption of infection chains and for protection against overloading our health care system (https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Teststrategie/Nat-Teststrat.html). The Federal Centre for Health Education (BZgA) provides information material on the tests currently in use (<https://www.infektionsschutz.de/coronavirus/tests-auf-sars-cov-2.html>). PCR tests are available as the gold standard. The PCR test is a standard procedure in the diagnosis of viruses. The test is based on the so-called polymerase chain reaction (PCR). In this process, the genetic material of the virus is multiplied. This makes it possible to detect viruses even if only a few pathogens are present. The PCR test therefore has high sensitivity, detecting the virus with a high degree of accuracy. In addition, only the genetic material of the SARS-CoV-2 coronavirus is specifically multiplied. The test thus has a high specificity, i.e. it detects exactly the targeted virus.

Rapid antigen tests for SARS-CoV-2 detect certain proteins of the SARS-CoV-2 Coronavirus in the mucous membranes of the respiratory tract during infection. Rapid antigen tests have been part of the national testing strategy since October 15, 2020 (Federal Ministry of Health 2020). They can provide a result within a very short time (around 15 minutes) and thus represent a possible preventive measure. However, the sensitivity of these tests is the subject of heated debate (Cerutti et al. 2020). Thus far, they have a lower accuracy than the PCR test. This means that a larger amount of virus is necessary for a positive result to be indicated. If, for example, only a few viruses are present shortly after an infection, the rapid antigen test can still be negative, even though the person tested is infected. Moreover, a rapid antigen test is not as accurate (specific) as a PCR test. This means that with the rapid test it occurs more commonly than with the PCR test for a positive result to be displayed when the person is not infected at all. A new test strategy is the so-called Lolli test, which allow a larger number of persons

needing to be tested to be pooled together. These Lolli tests have been subsidized since May 17, 2021 by the state of Baden-Württemberg for use in Freiburg schools. (See <https://www.badenwuerttemberg.de/de/service/presse/pressemitteilung/pid/land-unterstuetzt-lolli-testfuer-kinder-in-freiburg/>). Here, persons to be tested suck on a cotton swab for about 30 seconds. These cotton swabs are then evaluated together as a PCR test in so-called pools (for Lolli tests up to 30 pieces / class size per pool). Only when this pool tests positive does each person in the pool have to be tested individually. The aim is to test as many children as possible safely, yet keep the financial outlay within reasonable limits. It would be desirable if this test strategy could be transferred to the cultural sector in the near future. The authors are currently carrying out initial pilot projects for this purpose. Initial studies have proven able to demonstrate the effectiveness and practicability of the Lolli tests in schools (Joachim et al. 2021).

The first examples of the application of regularly recurring tests as part of a risk reduction strategy was reported by The Vienna Philharmonic and the Thomanerchor Leipzig (personally reported on July 15, 2020, by Prof. Sterz, Vienna and Prof. Fuchs, Leipzig).

The Berlin State Opera was also able to carry out a performance of Richard Wagner's *Die Walküre* on September 27th, 2020, by implementing daily tests (See report in the *Stuttgarter Zeitung* from Sept. 29, 2020). Indeed, the Freiburg Baroque Orchestra has already implemented numerous streaming projects, and live concerts in the meantime, with the aid of a risk reduction concept that includes PCR testing (carried out by the Freiburg Institute for Musicians' Medicine) of all people involved on and off the stage. Detailed risk reduction concepts can be set up in the professional music sector (opera, concerts, theater), that, depending on the facility, should be developed, and overseen by health care professionals (Böckelmann et al. 2020).

These concepts can be modeled on existing strategies found in professional sports, where extensive experience had already been gathered from national and international competitions of various contact sports – with partial resumption of play at the end of the first lockdown. Regular corona testing could also be set up, as is regularly practiced in

professional sport – for example, in the Bundesliga (soccer) in Germany. Joint Ventures between sports associations and music associations could be a way forward in future.

4.2 Air & Ventilation / Room & Space / Duration parameters

The epidemiological findings from the progression of the SARS-CoV-2 pandemic already show that the room/space and air/ventilation conditions, as well as the length of exposure to gatherings of people, are likely to have a decisive influence on the risk of infection (Leung et al. 2020; Chia et al. 2020; Santarpia et al. 2020; Liu et al. 2020; Miller et al. 2020).

Two different scientists have developed a very interesting set of calculation tools to be able to estimate how long a defined number of persons can stay in a specific space of a defined size that has a defined type of ventilation (Trukenmüller, 2020; Jimenez 2020). These are based on the previously known publications on the transmission of SARS-CoV-2 in closed rooms as well as on the existing model suppositions, in particular by Buonanno et al. 2020 a / b.

Hartmann & Kriegel have also presented a model calculation in which the air quality parameter – determined via the CO₂ concentration – is included in the risk assessment of virus-laden aerosols (Hartmann & Kriegel 2020).

The joint task group of the Hermann Rietschel Institute of the TU Berlin has published a model calculator that can be used to estimate the risk of COVID-19 infection by aerosols based on the parameters of room volume, activity, wearing a face mask, ventilation, and the amount of fresh air (<https://hri-pira.github.io/>). The suppositions are based on a publication by a joint working group of the Hermann Rietschel Institute, the Charité and the RKI (Kriegel et al. 2020).

The Berufsgenossenschaft Nahrungsmittel und Gastgewerbe (BGN) also provides access to a ventilation calculator on its website (BGN 2020 a).

It should however be noted regarding these calculating tools that the assumptions on which they have so far been based have not been based on actual knowledge of the viral

load in aerosols or knowledge of how many viruses are necessary for an infection. Rather, both important tools should be uniquely seen as prototypes. To this extent, these calculating tools have only been a guide to date from which no recommendations for action can reliably be derived.

The working group at the Freiburger Institut für Musikermedizin (Nusseck et al. 2020) carried out a series of measurements with 141 musicians at the Hochschule für Musik (HfM) Freiburg in September / October 2020. Here, room concentrations of CO₂ were measured during 47 lessons and rehearsals. The length of time for which a defined musical activity had to be interrupted and the room ventilated, was set using the European standard for interiors (EN 13779) for high indoor air quality (IDA 1), which is defined as a CO₂ concentration of 800 ppm.

In this way, it was possible to define for each room at the HfM a) how many people, b) with what musical activity, are allowed to stay in the respective room, c) for how long, d) until a CO₂ concentration threshold of 800 ppm was reached. Furthermore, we measured how many minutes the respective room had to be ventilated with cross ventilation, until the initial value of 400 ppm was again reached. The CO₂ emissions could be assigned to light and moderate music making activities (between 28 and 39 l / h). Wind and Brass instruments showed the highest CO₂ emissions. Singers, on the other hand, showed low emission rates, comparable to those of the control group, who only spoke and listened. The measurements enabled an individual risk assessment of instrumental and voice lessons, as well as rehearsals, depending on the size of the room and the number of musicians (Nusseck et al. 2020).

4.2.1 Singing and Playing Music Outdoors

Infections are especially likely to occur in people who spend a long time in closed rooms. In a study by Qian et al. in January and February 2020, in a total of 7,324 cases of infected people in China, the authors found that there was evidence in only *one* case of an infection being passed on outdoors (Qian et al. 2020). It can be assumed that aerosols dissipate faster outdoors, that deactivation of the pathogen is greatly accelerated (through UV, ozone, hydroxyl radicals, nitrogen oxides), and that the overall risk of

infection is therefore much lower. If minimum distancing is observed, the risk of infection while singing and playing music outdoors is considered to be very low.

Therefore, the first choice when making music with people who are not vaccinated and cannot be regularly tested is the outdoor option. A long cultural tradition exists here: we need only think of the ancient amphitheater. The term choir (ancient Greek χορός choros) originally referred to the dance floor of an amphitheater, in which people also sang. Brass music also has a tradition of taking place outdoors. Outdoor concerts are the predominant setting for Pop and Rock music. Audiences need to observe the prevailing protocols for groups and distancing, or creative solutions need to be found (e.g. “promenade concerts”).

4.2.2 Singing and Playing Music in Closed Spaces

- *Airing/Ventilation:* When singing and playing music takes place in closed rooms with natural ventilation, previous experience seems to show that regular and thorough ventilation (sporadic- and cross-ventilation) seems to be an important factor in risk reduction. The effectiveness of the ventilation can be checked by measuring the CO₂ concentration (see Nusseck et al. 2020). If the rooms are mechanically ventilated (ventilation and air conditioning systems, HVAC), a reduced risk of infection from aerosols can be assumed (aerosols are removed by way of natural ventilation via the exchange of air in the range of approx. 0.5–2/h even with closed windows; for HVAC, e.g., the air exchange rate in concert halls or performance halls is approx. 4-8/h; beginning at an air exchange rate of 6/h, one can assume that sufficient aerosols are being removed). The performance of an HVAC system can be checked using CO₂ measurements.
- *Air purifying devices:* research by the working group of Kähler at the Universität der Bundeswehr in Munich shows that by deploying a TROTEC TAC V + in a room with a floor area of 80 m² the concentration of aerosols could be reduced to a low level within a short period of time (Kähler et al. 2020). Also, the Berufsgenossenschaft Nahrungsmittel und Gastgewerbe (BGN) recommends: "If the adequate supply of outside air is insufficient, so that neither the required minimal

concentration nor the offered reduction in concentration of CO₂ can be achieved, the concentration of aerosols in the room air can be further reduced through additional measures such as the deployment of so-called air purifiers."

- As an alternative to the commercially available air purifiers, employees at the Max Planck Institute for Chemistry in Mainz have developed a low-cost exhaust air system that you can build yourself, which leads to a significant reduction in the CO₂ concentration by a simultaneous reduction in energy loss compared to sporadic room airing via the windows (Klimach & Helleis 2020).

However, in its statement on infection protection regarding air purifiers, the RKI raises concerns: "The false assumption that using such a device inside a room allows further measures to be abandoned, e.g., compliance with distancing rules or wearing a face mask, should be avoided at all costs. It is therefore important to ensure that the use of such devices does not lead to a feeling of "false security" and that the recommended infection preventive measures (AHA + L rule) are still followed" (RKI, 2020).

The Bundesamt für Umweltschutz (UBA), like the expert group on aerosols, therefore, advises against using air purifiers as a sole preventive measure. Rather, air purifiers can be used as an addition to the regular and appropriate ventilation of rooms.

- *Room size*: The area and height of a room, the number of people in that room, as well as the activity and the length of time they are in a closed room all appear to play an important role (Tellier 2006). A relatively large number of people who remained in confined and poorly ventilated rooms for a long period seem to have contributed to the spread of the outbreaks in Ischgl and Heinsberg.

Regarding group music making, very large spaces such as church interiors, concert halls, or city auditoriums could also be increasingly used as rehearsal spaces. Generally speaking, this spatial constellation could be referred to as a "cathedral situation". An optimal room volume of 60 m³ per person can be presumed here by a floor area of 4m² and 15m room height (Kähler, personal communication 2020). To

put into perspective that such spaces actually exist, one needs only to visualize the Freiburg Minster where the central nave is 125.83 m long, approx. 30 m wide and 25.70 m high. The room volume of the Freiburg Minster (including side aisles, transept, crossing dome and choir) is 80,300 m³. For example, if 937 people could be “placed” in the assumed calculated area of 3750 m² in the Freiburg Minster, each one would have use of a 4 m² floor area.

The room volume would be sufficient since each person would have 85.67 m³ available for use. It should be emphasized at this point that this model calculation is not to be understood as an actual recommendation for letting so many people into this space. It is only intended to illustrate how the relationship between floor area and room volume might look in a cathedral structure with this number of people.

- *Rehearsal length:* Using the known values of room size, type of activity, number of people, and CO₂ concentration one can calculate the corresponding time periods to determine when ventilation must be carried out. These rehearsal periods are – except for concert halls with HVAC systems – shorter than were usual in pre-Corona times and can be 20 minutes or even shorter depending on the circumstances. The time periods should, however, be checked using CO₂ measuring devices and then used as a guide. A general rule for when to ventilate has not been determined with sufficient precision.

4.3 Individual Protective Measures

- *Mouth-nose protection:* From our point of view, wearing a mouth-nose-protection (surgical face mask) represents an important means of reducing risk, particularly in the music sector. It is particularly important that face masks be worn, even though they may be perceived as inconvenient or disruptive while singing or playing a string, plucked, or keyboard instrument. The medical differentiation between wearing filtering half-masks (N95) or wearing surgical face masks is whether the aim is to be protected from infection by droplets or aerosols from other people (own protection), or whether the aim is to reduce the spread of infectious material to other persons

(protection of others). When wearing mouth-nose protection, both possible effects combine.

The material of the medical face masks, type II (according to DIN EN 14683: 2019-6), that are currently readily available surgical face masks, absorbs $\geq 92\%$ of the particles $\geq 3 \mu\text{m}$ in diameter. Thus, they represent a sensible measure for protection of others, but also offer relevant own protection (according to measurements of the Instituts für Infektionsprävention und Krankenhaushygiene des Universitätsklinikums Freiburg (IuK), they retain e.g., particles $\geq 0.5 \mu\text{m}$ to approx. 80–90% and particles $\geq 0.3 \mu\text{m}$ to approx. 70–80%).

However, the correct mask fit also plays an important role here, as air particles can escape laterally past the masks, especially during forceful exhalation (Mittal et al. 2020). Current studies have shown that wearing such masks can effectively reduce the spread of droplets and aerosols (Leung et al. 2020).

In the last two years, further publications on the subject of Coronavirus and the wearing of MNP have appeared that advocate the wearing of masks based on the latest scientific findings. They are briefly presented below.

On the one hand, it has been shown in animal experiments that by using masks the risk of infection can be significantly reduced (Chan et al. 2020).

On the other hand, a review study found that in the countries that consistently pursued the wearing of masks at the beginning of the pandemic – such as Taiwan, Japan, Hong Kong, Singapore, and South Korea – the incidence and death rates were significantly lower than in regions in which these measures were initially not recommended – such as New York (Prather et al. 2020).

This finding is consistent with the observations made by the working group around Mitze, who accept that a 40 percent reduction in infections in and around Jena was due to mask wearing (Mitze et al. 2020 English a / German summary b). In the German-speaking area, the German Society for Pneumology (DGP) also published a favorable opinion about wearing masks at the end of May 2020 (Pfeiffer et al. 2020).

Furthermore, the filtering effectiveness of different types of masks was examined by the working group around Koanda (Koanda et al. 2020). Importantly, it could be ascertained, that even self-sewn masks achieve a practical filtering effect – especially if they are made of different materials in multiple layers.

The working group around Stutt also emphasized the positive effect of wearing a mask in a modeling (Stutt et al. 2020), as did the working group around Wang in their epidemiological study (Wang et al. 2020), and as did the extensive meta-analysis of the working group around Schünemann (Chu et al. 2020).

Even the WHO recommends the wearing of masks as a fundamental component of infection protection for the general population in an Interim Guidance document already released on June 5, 2020. (WHO 2020).

Further studies show that the correct fit of a mask has a major influence on its filtering effect (Clapp et al. 2020).

Wearing face visors, however, does not offer comparable protection, as the visor is open at the bottom and to the side and therefore does not guarantee any protection from the spread of aerosols.

- *Distancing protocol:* observing the distancing rules remains important in protecting against droplet contamination, in the music business, too, especially when it is not possible to vaccinate and daily testing cannot be carried out. Since compliance with distancing protocols requires great attention – physical closeness and social connection are intuitive parts of music-making situations, and since singing and music-making do not take place with a rigid body position, but rather require a certain amount of freedom of movement – we believe that the distance between people should be 2 meters/6.6 feet to the front and 1.5 meters/5 feet sideways. An additional benefit can be simultaneously achieved by applying the circular distancing rule of 2 meters to a larger number of people in a closed room. Thus, by applying this rule, only a few musicians can fit into small rooms. With larger ensembles, a larger room size becomes necessary if this rule is to be observed. As a result, a minimum radial distance of 2 meters/6.6 feet can help to reduce not only the risk of droplet

transmission, but also the risk of increased indoor aerosol accumulation. However, compliance with distancing rules does not negate the need for regular ventilation and/or shortening of rehearsal times.

In the case of a choir or orchestra in which all members have been vaccinated and have recovered (2 G Rule), we consider it reasonable to lift the social distancing requirement. This recommendation takes into account, on the one hand, that those making music are generally arranged behind one another and are not facing one another directly. On the other hand, vaccination has turned out to be a measure that greatly reduces risk (cf. p. 37 ff.). While there is a residual risk of vaccinated persons – and those who have recovered from the virus, too – of becoming infected, these so-called breakthrough infections usually run their course with mild symptoms, or even none at all. Moreover, by following strictly the 2 G concept, even in the case of a person with the breakthrough infection, a greater risk reduction can be assumed; this is because an individual who could potentially infect others by means of a breakthrough infection encounters a group of people who for their part are immunized and thus present only a very slight risk of becoming infected themselves. In the case of 2 G, therefore, only a minimized, residual risk can be assumed as a rule. In special one-off cases – due to previous illnesses or old age, too – in which, despite full vaccination, it is unclear to what extent immune competence is present, there is medically speaking the option of determining the immunity status of the patient concerned by means of antibody titers. This is also possible for people who despite vaccination continue to suffer great fear of infection. In case the antibody titers prove insufficient, there is the possibility of administering booster vaccinations.

Despite the recommendation to lift the distancing rules in the case of 2 G, care should be taken with regard to a large room volume and optimal ventilation conditions; these can prevent a potential accumulation of virus-ridden aerosols, which can be excreted by a person with a breakthrough infection. For those

persons who are not allowed or do not wish to be vaccinated on medical or other grounds, we expressly recommend PCR testing that is updated daily.

- *Specific measures:* The area of individual protective measures includes further specific aspects for individual instruments (e.g., saliva protection and partitions between singers and coaches).

4.4 Vaccination

Vaccination began in December 2020 and is newly recognized as the fourth essential pillar of managing the corona pandemic. Official vaccination started in Germany on December 27th, 2020.

Present day vaccination has a long pre-history. Presumably there had already been a transfer of material from smallpox sores to healthy people over a thousand years ago in Central Asia. The process was called inoculation or variolation. This method came to Europe via China, Arabia, and the Ottoman Empire. It was also used in North America: 287 people were inoculated during the Boston smallpox epidemic in 1721. The results were scientifically evaluated and published: of those inoculated six died after being infected with smallpox (2%), while 842 of 5,759 non-inoculated people (15%) who had smallpox died.

The English doctor Edward Jenner carried out a successful smallpox vaccination in 1796 and called the process vaccination because he used material from sores of a milk maid who had suffered from cowpox (cf. Eckert 2011).

In 1980 the World Health Organization (WHO) announced the eradication of smallpox as a result of a worldwide vaccination campaign, that had been consistently carried out for more than a decade.

Smallpox was not the only infectious disease against which effective vaccinations had been developed. In 1880, Louis Pasteur managed to develop a vaccine against cholera, followed by vaccines against anthrax in 1881 and against rabies in 1884. In the 20th

century, numerous vaccines followed, including against so-called "childhood diseases" such as rubella, measles, mumps and chickenpox, the effectiveness of which has been scientifically proven (cf. CDC 1999). A vaccine could also be developed against virus-related polio, poliomyelitis, from which the violinist Itzhak Perlman, who was born in 1945, fell ill at the age of four.

This has been successfully used worldwide in the so-called oral vaccination form. Rotary International has supported a worldwide vaccination campaign under the name PolioPlus since 1985, that can report great success: in 1985 there were still 350,000 new infections in 125 countries worldwide per year, while in 2019 the number of annual new infections was only 173 worldwide. This is a reduction of > 99%. The aim of this campaign is to interrupt the transmission chain worldwide by 2023 (see End Polio Now). Vaccination can also make a significant contribution towards rapidly achieving a so-called herd immunity in the case of newly emerging infectious diseases, such as the Covid-19 disease caused by the SARS-CoV-2 coronavirus. For this to happen, as many people as possible need to get vaccinated. The percentage varies depending on the infectiousness of a pathogen. In the case of SARS-CoV-2, a base reproduction number R_0 of around 3 (3.3-3.8) is assumed for the (non-mutated) wild type. In addition to the originally widespread wild type of SARS-CoV-2, mutations are now increasingly being identified (e.g. English, Brazilian, South African or Indian variants, which according to the latest WHO terminology are no longer named after a country, but according to the date of their first description according to the letters of the Greek Alphabets), that are described as being more contagious than the wild type, i.e. having a higher basic reproduction value R_0 , but which do not seem to differ in terms of the basic transmission characteristics from the wild type, so that the risk-minimizing measures are the same. In addition, the vaccinations are also effective against previous known mutations according to current scientific knowledge, (Bernal et al. 2021). This also applies to the delta variant (Stowe et al. 2021).

For the newly occurring mutations that have appeared up to now, assume the basic reproduction value R_0 to be the number 5. Thus, to achieve herd immunity through vaccination, 80% of the population would need to be vaccinated. If this quota could be

achieved everywhere, then the Covid-19 pandemic – as a disease caused by a new pathogen against which the world population’s immune system hasn’t yet developed sufficient protection – could be transformed into an endemic disease. One speaks of an endemic disease when the product of the basic rate of reproduction (basic reproduction number R_0) times the susceptibility rate (susceptibility number S) is equal to one ($R_0 \times S = 1$). In the case of endemic disease, the disease has not disappeared, but the number of cases of disease in the population remains roughly the same and no longer increases exponentially (Lavine et al. 2021).

So far, four vaccines have been approved for use in Germany: According to the RKI, the two mRNA vaccines (Comirnaty (BioNTech / Pfizer), COVID-19 Vaccine Moderna) (two vaccinations of each required) have an efficacy rate of around 95% according to latest knowledge. The vector-based vaccine Vaxzevria from AstraZeneca (two vaccinations required) has an efficacy rate of up to 80% in all age groups, according to the RKI, and the vector-based vaccine COVID-19 Vaccine Janssen from Johnson & Johnson showed an efficacy rate of about 65% in all age groups and an effectiveness of about 75% against a severe course of the disease after receiving the recommended single vaccination dose. (www.rki.de)

According to RKI, “the performance parameters for all SARS-CoV-2 vaccines licensed in Germany that became known during or promptly after licensing have demonstrated safety, protection against symptomatic disease and outstanding efficacy against severe disease and death (Baden et al., 2021; Voysey et al., 2021). The vaccines therefore induce very good functional immunity.” (https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Vorl_Testung_nCoV.html;jsessionid=EAAB35C766A2A4E4BAB12D075F813333.internet122?nn=13490888#doc13490982bodyText14)

Very few vaccinated people have described serious side effects in the context of corona vaccinations worldwide. After vaccination with AstraZeneca and COVID-19 Vaccine Janssen (Johnson & Johnson), rare cases of thrombosis in combination with thrombopenia have occurred in vaccinated persons. An evaluation of more than 20

million people vaccinated with AstraZeneca in Great Britain showed 79 cases of thrombosis, of which 19 people died (Mahase 2021). This frequency of occurrence corresponds to approximately one case per 250 thousand people vaccinated and one death per 1 million people. So far, these severe and sometimes fatal side effects have mainly been observed in women aged ≤ 55 years, but men and the elderly have also been affected. Therefore, based on the current data, the STIKO generally only recommends vaccinating people 60 or older with the vector vaccines.

A current study examined the effectiveness of the mRNA vaccine from BioNTech / Pfizer in the population of Israel in the period from 01/24/21 to 04/03/21 (Haas et al. 2021). It showed very positive results. By April 3, 71.1% of the population had already received two doses. The efficacy of the vaccine was reported to be 95%. The incidence fell from 91.5 / 100K. back to 3.1. Despite the vaccination, there were isolated cases of infections, so-called "breakthrough" infections (Birhane et al. 2021). However, based on the data available so far, it can be assumed that the viral shedding in persons, who have become infected with SARS-CoV-2, despite having completed a series of vaccinations, is largely reduced after full vaccination and thus the risk of transmission is minimized. However, it must be assumed, that people can be infected after corresponding exposure, symptomatically or asymptotically, despite vaccination and thus shed SARS-CoV-2 (verified by PCR testing). The STIKO therefore recommends that the generally recommended protective measures (everyday mask wearing, hand washing, distancing, ventilating) continue to be followed even after vaccination. (www.rki.de, as of April 7, 2021)

Otherwise, there remains the possibility of adapting the vaccines in the future and refreshing the immunizations at regular intervals, comparable to the flu vaccination.

According to the Bundeszentrale für gesundheitliche Aufklärung (BZgA), the general willingness to vaccinate has increased in Germany in recent years. The number of people who strictly refused all vaccinations fell from 4% in 2012 to 2% in 2020.

(https://www.bzga.de/fileadmin/user_upload/PDF/studien/Infektionsschutzstudie_2020.pdf).

An investigation by our own working group showed that already 86% of the audience and creative artists questioned in June and July 2021 had received a first vaccine and only 3.1% rejected a Corona-protective vaccination in general. Hence, the vaccination rate and willingness to be vaccinated in the music business was very high at the time of the investigation when compared with the overall population (cf. p. 5 f., Spahn et al. 2021).

Studies with mRNA vaccines for children aged six months to twelve years old have been undertaken by manufacturers, and in part completed. In these age groups, too, vaccination is expected to be a vital pillar in protection against infection.

5 Vocal and Instrument-specific Assessment

Despite the option of being able to counter a SARS-CoV-2 infection and thus contracting the COVID-19 disease by means of vaccination – an option categorized as the most effective possible – what follows lays out the aspects of risk assessment specific to singing and instrument-playing. This is also because an important group in music making – namely, that of children and youths – could not be fully covered by vaccination to date, or only partially so.

5.1 Voice

5.1.1 General risk assessment with regard to singing

As previously described, a distinction must be made in the transmission pathways of SARS-CoV-2 between the risk of infection from droplets (containing viruses) and the infection from aerosols (containing viruses). In addition, it is important to note the other transmission pathways via hand/nose/mouth contact and, potentially, hand/eye contact.

Droplets: Due to their size and weight, droplets sink quickly to the ground and travel a distance of maximum 1 meter (39 inches). This is the basis for the distance rule of 1.5 meters (5') in everyday situations (shops, offices, etc.).

Is there an increased risk of droplet infection when singing?

In the field of voice physiology, it has long been maintained that no significant additional air movement occurs in front of a singer's mouth during phonation (sound production when singing) since sound waves travel physically without significant flow: the flame of a burning candle does not move in front of a singer's mouth, even if one sings loudly.

This observation was recently confirmed by measurements made of three singers with the Bamberg Symphony Orchestra. The artificial fog channeled directly in front of the singers' mouths was not visibly redirected by singing even at different pitches, different

volumes, or different vocal styles. By forceful articulation, e.g., with consonants (plosives, fricatives), slight turbulences in the fog were observed in close proximity to the singer's mouth. However, when measuring the air speed with sensors set at 2 meters/6.6 feet from the singer, no air movement could be detected. This distance of 2 meters/6.6 feet can therefore be viewed as a protective distance against droplet infection even by forceful articulation (Richter et al. 2020).

These observations are in line with other research groups who recently used different optical methods to visualize the spread of air when playing a wind instrument and when singing (Kähler & Hain 2020 a/b; Becher et al. 2020 a/b; Echternach et al. 2020; Sterz, 2020; ORF 2020).

Aerosols: Reproductive capable pathogens are merged with aerosols in the airways, e.g., chickenpox virus, influenza viruses, measles virus, mycobacterium tuberculosis, and obviously, SARS-CoV-2 as well. When aerosols emerge from the mouth opening, it is to be expected that they will initially rise, due to their lower specific density (at approx. 37° Celsius and by a relative humidity >95%), and then mix with the room air. Sedimentation of aerosols is not a factor below a particle size of approximately 4 µm for all practically purposes.

It has been shown that aerosol formation increases when speaking volume gets louder (Asadi et al. 2019). Two scientific studies by the Charité on aerosols when singing are available: the first examined adult singers, the second children. (Mürbe et al. 2020 b, c).

Is there an increased danger from aerosols when singing?

Basically, it should be assumed that singing can produce aerosols that transmit viruses just as resting breathing or speaking can (Fabian et al. 2019). On the whole, the measurement of aerosols poses a technical challenge.

Several working groups are currently in the process of measuring aerosols while singing. Bavarian Radio (br) reported in a radio broadcast on May 22nd, 2020, about a study by Prof. Dr. Matthias Echternach, Univ.-ENT Clinic Munich (LMU) and PD Dr. Stefan Kniesburges, University ENT Clinic Erlangen (BR-Klassik Astell May 22nd, 2020). On

April 7, 2021, there was a detailed film report about this investigation shown on Bayerische Rundfunk (TV), in which the authors Echternach and Kniesburges explained their results. In broad agreement with our own measurements of air movement, the authors state their results in a publication now available, that during singing the aerosol clouds spread out up to distance of 1.5 m in the direction being sung. The distance of spread to the side of the singers was significantly less. Consequently, the authors recommend a minimum distancing of 2 m to the front (better 2.5 m) and 1.5 m to the side for safety (Echternach et al. 2020).

On May 27th, 2020, a protocol of an investigation and a photographic documentation of aerosol and condensation water emissions from choir members was published on the homepage of the Austrian Choir Association, under the leadership of Univ. Prof. Dr. med. Fritz Sterz of the Medical University of Vienna (Sterz et al. 2020).

The Rundfunk Berlin-Brandenburg broadcast a television report on June 3, 2020, about an investigation by Prof. Dr. Dirk Mürbe from the Charité and Prof. Dr. Martin Kriegel, from the Hermann-Rietschel Institute of the TU Berlin (rbb practice, June 3rd, 2020). The results of this working group are published as a preprint (Mürbe et al. 2020 (b, c); Hartmann et al. 2020; Hartmann & Kriegel 2020; Kriegel & Hartmann 2020).

On June 26th, 2020, a Japanese working group, consisting of members of the Tokyo Metropolitan Symphony Orchestra (head: Kazushi Ono) in cooperation with the aerosol researcher Professor Tomoaki Okuda (Keio University) and Dr. Hiroyuki Kunishima from the Department of Infectious Diseases at St. Marianna University published a report on aerosol measurements with brass players and singers (Ono et al. 2020).

Inhalation

The extent to which deeper breathing while singing increases the risk of infection has not yet been scientifically investigated.

Phlegm production

Putting other factors in tone production aside, singing can produce a not inconsiderable amount of phlegm. For one, it is not uncommon to observe that extra phlegm is produced when warming up for singing, which is then expelled from the respiratory system by

coughing or clearing the throat. Likewise, prolonged singing can lead to increased formation of phlegm due to stress on the respiratory tract.

Conclusion:

Based on the inter-relationships and results shown, we assume that singing does not increase the risk of droplet transmission if a distance of 2 meters/6.5 feet to the front and 1.5 meters/5 feet sideways is maintained. Based on the latest measurement results, it does not appear necessary to extend the distance to 3–5 meters/10–16.5 feet, as we had initially formulated in the first risk assessment from April. 25, 2020. The extent to which aerosol formation and diffusion are *specifically changed by singing* can currently still not be fully assessed, as the emission rates show a wide range of fluctuations (cf. Morawska et al. 2009). However, the data collected so far suggests that singing can lead to significantly higher emission rates of aerosols when compared to breathing through the mouth and speaking; on average, the emission rate is effectively 30 times higher (Mürbe et al. 2020 (b)). The CO₂ contents of the air is an important place to start when assessing the risk of infection via aerosols. It can be used as an indicator of the accumulation of aerosols in the air, which may contain SARS-CoV-2 viruses (Hartmann & Kriegel 2020). Max Pettenkofer established in the middle of the 19th century that gaseous carbon dioxide (CO₂) is an important measure of air quality. He is viewed as one of first to recognize hygiene (public health/ sanitation) as an independent science in Germany. He realized that CO₂ is not just a measure of air quality, but that other substances in the air also react proportionally to the amount of CO₂ therein (Pettenkofer 1858). The so-named *Pettenkofer Number* set the amount of CO₂ at 1000 ppm according to Pettenkofer, compliance with which is required indoors, especially in schools - regardless of singing (Communication from the Federal Environment Agency 2008). For this purpose, there are simple, relatively inexpensive measuring devices that also display the air quality visually in the sense of a “traffic light”. These allow the air quality to be assessed and thereby, indirectly, the risk of infection via aerosols in closed rooms; and can be used to help control the required ventilation in naturally ventilated rooms.

To ensure that the highest air quality is maintained according to EN 13779 in the context of the pandemic, we recommend setting a threshold value for ventilation at 800 ppm of CO₂. A current study by the Freiburg Institute for Musicians' Medicine on measurements of the amount of CO₂ in music-making situations has been published as a preprint (Nusseck et al. 2020). Consequentially, currently available knowledge leads us to the point of view that necessary protective measures be proposed. These are detailed below, where singing is addressed in its individual forms and settings. In addition, we also recommend members of all settings be vaccinated. If all members of a choir have been vaccinated, then from our point of view the risk has been reduced to a minimum for all participants.

As a consequence of the knowledge available, it is our view that necessary protective measures must be proposed. These are prescribed in each case by the particular forms and settings in which the singing takes place. We recommend for all settings that the choir members be vaccinated provided this is possible from a medical viewpoint. In our view, if all members of the choir have been vaccinated twice, an infection risk for all those involved exists that has been reduced to the minimum (cf. p. 65).

We believe that it is a reasonable risk to rehearse a choir that has been vaccinated twice – or with singers who have recovered from the virus – with the social distancing rules lifted. Should a member of the choir not be able or allowed to receive a vaccination on health grounds, we consider in this case a daily-updated PCR test an imperative requirement, in order for this person to be able nonetheless to participate in the rehearsal at a similarly reduced level of risk.

5.1.2 Forms of singing practice

Individual vocal coaching

With solo singing, a deep inhalation and exhalation occurs during sound production. To the best of our knowledge, the extent to which this increases the risk of infection has not

yet been scientifically investigated. Even if the direct air flow is not stronger in singing phonation, as our latest measurements have confirmed, it can be assumed that viruses are spread through aerosols during singing. In solo singing, spitting particles, i.e., droplets, are expelled when consonants are formed. The short range of these droplets has been described above.

Direct transmission of droplets can also be reduced by installing plastic partitions (so called Roll-ups). Noise protection screens already available in some institutions could also be used as makeshift droplet protective barriers. However, it should be noted that partitions influence the movement of the air in the room and thus the accumulation of aerosols. They can also hinder the exchange of air when airing out the room. Here CO₂ measurements can be a valuable aid in monitoring the effect on the course of the ventilation plans, especially when readings above 800 ppm are reached, at which point ventilation should take place.

In addition, it makes sense to us that teachers wear additional face and nose protection (FFP-2/ N95 masks are recommended) during individual lessons when students are singing. This recommendation applies especially when a student and teacher are not vaccinated.

By strictly observing the safety measures (based on the most up-to-date standards, in particular – distancing of 2 meters/6.5 feet to the front and 1.5 meters/5 feet sideways (see above)) and the preconditions for usable spaces (sufficient room size, ventilation breaks based on CO₂ concentration – especially important when teaching in small groups and with individual students) risks in individual lessons can be significantly reduced, in our view.

However, it cannot be inferred from this updated risk assessment that teachers or students can be obliged to teach or take part in individual face-to-face lessons. In our opinion, if the structural and organizational requirements are not met or the people involved belong to a risk group, then face-to-face teaching should not take place, but could be possible online.

Choral singing

Choral singing generally follows the characteristics of the singing process described above. Since it must be presumed that each and every singer creates aerosols, it is to be expected that aerosols containing viruses will accumulate in a higher concentration in an enclosed space when a large number of people gather (Liu et al. 2020). If infected people engage in singing in a room, then the result will be an accumulation of virus-containing aerosols. The quality of room ventilation also plays an important role here (Li et al., 2020). The question of the duration, i.e. how long a choir rehearsal lasts, also plays a role in the expected concentration of aerosol particles in a room. Over longer periods of time, particle concentration can rise to higher values than in shorter periods. There have been repeated reports of the spread of SARS-CoV-2 infections among several different choirs after choir rehearsals and religious services. A scientific publication reported on one such outbreak in a choir in the United States on May 12 (Skagit County, Washington) (Hamner et al. 2020). A high infection rate was reported by the choir to the health authorities on March 17, 2020. The choir rehearsal, which presumably led to the high infection rate, took place on March 10, 2020. Of the 61 choir members who took part in the rehearsal on March 10th, 53 fell ill, three had to be treated in hospital, and two died. The median age of the singers was 69 years (range = 31–83), the three hospitalized patients had two or more known medical conditions. Infection via aerosols is discussed in the publication as a likely source. However, other influencing factors are also critically examined. The distance between individual singers was small, 6–10 inches (about 15–25 cm) between the chairs. The entire rehearsal lasted approximately 2-1/2 hours. There was a 15-minute snack break. In addition, the presumed index person, who is suspected to be the primary source of viral spread at the rehearsal on March 10th, had already been symptomatic on March 7th. That person had also participated in the March 3rd rehearsal.

How can the risk of a CoVid-19 infection be reduced when singing in a choir?

In order to mitigate the risk of infection from aerosols in the choral setting, as many choir members should be vaccinated as possible. If this is not possible, *masks* can be worn, as already explained above.

In addition, singing in very *large rooms*, such as concert halls or church interiors (cathedral conditions, see above), appears to be most advantageous. A regular *airing out* of the room based on the CO₂ concentration in the room air, or by using rooms with an HVAC system (supplying fresh outside air, not recycled air) are important risk-reduction measures.

In enclosed rooms where only natural ventilation is possible, regular testing of the air quality using the CO₂ “traffic light” device - as already described above - can significantly improve ventilation measures.

This measure is generally recommended when many people remain in a closed space over time, because singing causes more aerosols to be expelled, as does speaking and deeper exhalation e.g., just by moving about.

Using such a CO₂ “traffic light” device would allow singing to be integrated into a group setting and no longer present an additional uncontrollable risk. The value of 800 ppm should be considered a critical threshold or critical level here. Whenever a CO₂ concentration of 800 ppm is measured in the room air, ventilation must follow. The ventilating action should continue until the concentration of CO₂ has fallen back to its initial value (usually between 400 and 500 ppm). The CO₂ “traffic light” device shouldn't be mounted on the walls, but instead, when possible, be set up in the middle of the room (e.g., atop an upright or grand piano). The application of CO₂ measurement as a part of the hygiene procedures in dance medicine (TaMed) has also been reported in the field of Dance/Movement (TaMed 2020).

These recommendations will be maintained for the coming six months of winter, too, if a 2 G Rule is in place, as they will once again reduce the residual risk.

It appears that the most favorable way to minimize risk is to sing *outdoors* (see also Systemic Risk Reduction). In addition, using CO₂ testing to divide up the *rehearsal times* into short sections can contribute to minimizing the risk in rehearsals.

To eliminate droplet transmission, choirs should observe the general *spacing rule* for social distancing, even in the choir breaks, as well as both before and after the rehearsal, especially when face-to-face contact occurs; face masks may also be worn to protect against droplet transmission.

Above and beyond that, it is our view that particular care must also be taken during breaks so that unavoidable contact does not take place, e.g. in narrow hallways or doorways, and to ensure that there is no hand contact or contact with surfaces (e.g. by sharing music, etc.). Regular and thorough *hand washing* is very important. One should particularly avoid touching the face and rubbing the eyes. Sneezing and coughing should be avoided, if possible, and caught in the crook of the elbow.

A further general risk reduction is the individualized *entrance screening* (see above).

In our view, it is desirable that for those choirs fully immunized a degree of “choir normality” returns soon and that singing can take place without social distancing.

However, it should be added that decisions should be on an individual basis, dependent upon the age of those singing and the date of their vaccinations. The younger the participants and the more recent their vaccination dates, the more justifiable is the reduction in inter-person spacing.

Choral singing with children

Provided the children who sing in a choir are already regularly tested several times a week through their respective schools and the result is negative – the method preferably being that of a “Lolli PCR Test” – then the risk of infection can be assessed as very slight within the group. As explained in the announcement made by the Ministry of Culture of Baden-Württemberg dated August 27, 2021 ([Kultusministerium - CoronaVO Schule \(km-bw.de\)](https://www.kultusministerium-bw.de/Presse/Pressemitteilungen/2021/20210827-CoronaVO-Schule)):

“The Ministry of Culture will continue mandatory testing in schools and school-run kindergartens as a security fence. Excluded from this are immunized persons, i.e. those vaccinated or recovered from the virus. Moreover, mandatory face coverings still apply, regardless of the incidence rate. Thus, it still applies even if the value falls below an earlier threshold. Exceptions to mandatory face covering still remain in force, however.

Masks must not therefore be worn during specialized sports teaching, for example, or during vocal coaching, and with brass instruments. [...]” This lifting of mandatory face covering is important, as restrictions in the area of ensemble and choral singing can have far-reaching consequences, especially for children and adolescents. Singing together is an integral part of the cultural life at school and is an important factor in the socio-emotional development of children and adolescents. This also applies to music schools and children's and youth choirs (n.B. in Germany). First results on aerosol emissions among singing children are presented in a pilot study by the working group around Mürbe (Mürbe et al. 2020 c). Results showed here that higher aerosol emissions were also found in children during singing than when speaking, corresponding to the results from adults. There is also a great variability in aerosol emissions among children. A correlation between particle emission and vocal volume could be confirmed, especially in the phonation form of "screaming". Compared to the previously published data on speaking / singing of adult professional singers, the speaking values for children lay in a similar range, however the singing values were *lower* for children than for adult singers. Interestingly enough, individual children achieved higher emission values when “screaming” compared to the values achieved by adult singers when singing loudly. On May 18, 2021, the same working group published a preprint comparing 15 primary school children, all between the ages of 8 and 10, to 15 adults (Mürbe et al. 2021). Both groups were examined in a “clean room” using a laser particle counter. In this connection the emission intensities for the test conditions of resting breathing, speaking, singing, and calling out, as well as for sustained phonation at different volumes of voice were determined. A comparison with the values for adults showed significantly lower emission rates for children when breathing at rest, speaking, and singing. The (correlation) factor between children and adults amounted to 2.8 when breathing at rest, 5.9 when speaking and 13.4 when singing. When calling out, there were no significant differences between the two groups.

Nevertheless, the distancing and hygiene protocols as well as an appropriate ventilation plan apply to children's and youth choirs until further notice. In addition, the number of

singers and the duration of rehearsals and performances should also be appropriately limited, as already described in the previous chapters.

Since the vaccine from BioNTech / Pfizer has now been approved for use in Germany for children ages 12 and above and Moderna has applied for approval, a solution for joint music making among children and adolescents has also come into view. In addition, studies are ongoing in the United States on the effectiveness of the vaccine in children between 6 months old and 11 years of age. Parallel to that the possibility of testing children by means of “lollo” tests also exists (see p. 27ff.). If all children who sing in a choir still test negative after being tested twice a week with the “Lolli PCR” test by their respective schools, then the risk of infection within this group can be classified as very low. According to the most current Corona ordinance issued by the state of Baden-Württemberg (as of June 3, 2021), the submission of a negative test certified by the school is sufficient in future to permit pupils access to all permissible activities, as long as the test is no more than 60 hours old. (<https://www.badenwuerttemberg.de/de/service-/presse/pressemitteilung/pid/weitere-lockerungen-unterleichterungen-ab-7-juni/>)

How the Corona pandemic effects children and adolescents has already been under investigation since the first lockdown (Ravens-Sieberer et al. 2021). A quick return to "normality", where children and adolescents can once again participate in cultural offerings, seems all the more important.

Singing in church services

Congregational singing appears possible if the distancing rule of 2 meters/6.6 feet is observed and face masks are worn, since it can be assumed that services usually take place in large to very large spaces. Church rooms with a ceiling height of 10 meters and more usually have such large room air volumes (cathedral situation, see above) that in terms of infection risk they are comparable to smaller rooms with more powerful ventilation systems (air change 6 / h). Where this is not the case, the air quality and the effectiveness of the ventilation can be checked directly on site using the CO₂ “traffic

light” device - as described above. The ventilation plan will then need to be optimized based on the CO₂ values collected on site.

Within a church setting, rehearsals and church concerts are currently permitted again, though the social distancing rule and mandatory face covering are still in force for events and services in churches; this is because no access checks take place in line with 2 G or 3 G rules (ebfr.de).

3.2.2. Playing wind instruments

General risk assessment

Just as with singing, the previously recommended distances can also be waived when wind instruments are played, in strict accordance with the 2 G rules (cf. Risk Management p. 65). This is the case for children and teenagers, too, provided valid testing is regularly carried out in schools. Nonetheless, in what follows we will keep the comments previously made concerning risk assessment to ensure that the information contained therein remains available.

Except for flute instruments (recorders and transverse flutes), experienced players of wind instruments do not leak any air at the contact points where the player lips and the respective mouthpiece meet (Brass instruments, single and double reeds). With some wind instruments, air escapes out of the keyholes for certain notes, but in general, wind instruments possess a sound opening, e.g., in the form of a bell. Each wind instrument is to be considered individually because of their special features.

As a common feature - apart from the flutes - it can be stated that sound is created by vibrations of the lips of the mouth (brass instruments) or is interrupted by double-reeds in the mouth or reeds on the mouthpiece (double-reed instruments among woodwind instruments). Similar to singing, only small amounts of air per unit of time flow out of the bell of the instrument with wind players. The measurements done with the Bamberg Symphony Orchestra by Dipl. Eng. Schubert from the firm Tintschl, which were carried out at the beginning of May 2020 and scientifically evaluated by our working group, support these assumptions (Spahn et al. 2020). These observations and measurement results are also supported by the results of other working groups (Kahler & Hahn 2020 a/b; Becher et al. 2020 a/b/c; Echternach & Kniesburgs 2020; Sterz, 2020; ORF 2020; NFHS 2020). On May 17, 2020, ORF Kultur published a report on a study with the Vienna Philharmonic, in which as Univ. Prof. Dr. med. Fritz Sterz from the Medical University of Vienna presented a photo documentation on the differentiated breathing of different wind instrument players (ORF 2020).

On November 25th, 2020, Bayerischer Rundfunk (br) reported on a study by Prof. Dr. Matthias Echternach, Univ.-ENT Clinic Munich (LMU) and PD Dr. Stefan Knieburg, Univ.-ENT Clinic Erlangen. In broad agreement with our own measurements of air movement, the authors state that the aerosol clouds created by the wind players spread out less than 1.5 m forward away from the players. The flutes formed an exception, in this case the aerosol clouds spread out up to 2 m away in the direction being played. The distance of spread to the side was significantly less. The authors' recommendations for safe distancing when playing wind instruments are therefore keep a minimum distance of 2 m to the front and 1.5 m to the side, and for flutes a minimum of 3 m to the front and 2 m to the side. The scientific publication of these data is still pending. Based on the previously described transmission pathways of SARS-CoV-2, a distinction between the potential risk of infection by means of virus-containing droplets and by means of virus-containing aerosols when playing must be made. To these are added the important transmission pathways of hand contact and of hand-to-eye contact.

Droplets: Due to their size and weight, droplets sink quickly to the ground and reach a maximum distance of 1 meter (3'3"). This is the basis for the distance rule of 1.5 meters (4'1") in everyday situations (shops, offices, etc.).

Is there an increased risk of droplet infection when playing a wind instrument?

Since no air escapes at the contact point between the player and the respective mouthpiece of brass instruments, woodwind instruments with a single reed (clarinet and saxophone) and double reeds (oboe, bassoon), as well as the recorder when the instrument is mastered, no droplets can be released directly into the environment from the player's mouth while playing. When playing the clarinet, however, inexperienced players (e.g., beginners as well as older clarinetists), especially by longer rehearsals, can, in individual cases, cause secondary air to escape alongside the mouthpiece when the lips become fatigued. This secondary air flows over 90 cm into the room (cf. Becher et al. 2020 a). This cannot be observed in physiologically 'correct' playing.

This is different with flute instruments (flute, recorder). Especially with the flute, air is blown directly from the mouth of the player into the environment when blowing across the mouthpiece, whereby droplets can be released. Measurements regarding air speed taken of the Bamberg Symphony Orchestra show that no air movement could be detected at the sensors, when placed at a distance of 2 meters/6.6 feet from the flute mouthpiece. Therefore, transmission by droplet infection is very unlikely at this distance. With the recorder, the lips surround the beak of the instrument, so that no droplets can leak into the surroundings. On the other hand, droplets could form when the air flow is broken up at the labium of the head piece. In measurements taken with the Bamberg Symphony Orchestra, when the recorder was played air movement around the labium was no longer measurable at a distance of 1.5 (4'1") meters. Therefore, transmission by droplet infection is very unlikely at this distance. (Spahn et al. 2020)

Condensation: Condensation is created when warm, moist breath inside the instrument—whose inner walls are markedly colder—condenses as drops of water. During this process, any aerosols contained in the exhaled air are greatly reduced (air purification principle [Luftwäscher-Prinzip]). If the breath is from a virus carrier, the question arises whether and to what extent this condensation (which brass players need to release via the water key during breaks), contains viruses and is therefore potentially infectious. Measurements regarding the viral load in condensed water are still pending. We recommend collecting the condensed water in containers or with a cloth and cleaning or swabbing the instruments regularly.

Aerosols: When aerosols escape from the mouth, they rise due to the low specific weight of exhaled air. They spread out into the available space, whereby sedimentation no longer plays any practical role. A reduction can only occur as a result of a dilution with the volume of air available in the respective space and through the natural exchange of air.

Is there an increased risk of aerosols when playing wind instruments? Aerosols do not escape into the room air directly from the mouth when playing wind instruments, except

for the flute. They reach the environment via the body of the instrument and through open keys, holes and/or the bell. A distinction must be made between the possible exit points among different wind instruments. In brass instruments, air exits through the bell. With woodwind instruments, air only exits through the bell when all side holes are closed, e.g., by the lowest note of the respective instrument. Exceptions to this are the oboe and the English horn, in which air escapes through the last open side hole even when the instrument is playing its lowest note. In addition, the air escaping through the first open side hole changes depending on the pitch played in woodwind instruments. With the flute, the air flow can be compared to the flow of an exhalation. The air flow is diverted in accordance with the Coanda effect. With the recorder, the lips enclose the mouthpiece of instrument, and the air flow is broken up at the labium of the headpiece.

It is a physical assumption, that inside all wind instruments aerosol particles contact the inner surface, which then adhere to them, i.e., that the instruments fundamentally reduce the particle concentration of the given aerosol. The effect increases the longer the instrument airway is, the smaller its diameter, and the more bends it has. The effect governs all particle sizes, but the effect is more pronounced for larger particles than for smaller particles, e.g., viruses. As described above, the question arises to what extent the instrument also acts as a filter for aerosols (due to condensation of humid air and due to surface contact). Our working group (Schuster, Schumann, Spahn, Richter) carried out a series of various measurements to this purpose. Air was sucked in and channeled through the following brass instruments: trumpet, tuba, trombone, and fanfare trumpet. The concentration of particles was measured before and after the air was channeled through the instruments. The measurements were carried out using different suction pressures with the aim of achieving, as precisely as possible, the pressure existing within the instrument when played. From the point of view of the working group, the results are not yet applicable in practice, as further series of measurements must first be carried out due to methodological issues.

One way of reducing the escape of aerosols is to use protective attachments at the opening outlets of the wind instruments - comparable to masks when speaking and

singing. Some authors (cf. Kähler & Hain 2020; Willich et al. 2020; Becher et al. 2020 c) recommend using some sort of transparent protective material or tightly woven silk cloths (aka drop protection) placed in front of the bell of the brass family instruments. Until further clarification of the question, this could help reduce potentially escaping aerosols. A covering over the bell of woodwind instruments seems less effective for reasons already mentioned.

Becher's working group also included the effect of instrument-typical mutes in its investigations of brass instruments, (Becher et al. 2020 c). It was found that using mutes shortens the air flowing from the horn and deflects it to the side. Regarding CO₂ emissions from wind instruments, our own working group was able to show that the CO₂ emission rates for instrumental playing can be assigned values on a scale laying between both 'light' (29 l/h) and 'difficult' (39 l/h) physical activities. In this connection the emission rates for brass players are even higher than for woodwind instrumentalists (Nusseck et al. 2020).

To what extent the deeper inhalation needed to play a wind instrument increases the risk of infection has not yet been scientifically investigated.

From the receiver's side, the question arises to what extent virus loaded aerosols are absorbed in greater amounts when playing wind instruments due to the deep and often rapid inhalation, and to what extent higher concentrations of viruses thereby invade the respiratory system. To date, no scientific studies have been carried out on this topic.

For wind players, a not inconsiderable amount of phlegm can also be produced as a byproduct of playing. For example, it is not uncommon to observe additional phlegm being produced during warming-up, which is then removed from the respiratory system by coughing or clearing the throat. Likewise, prolonged playing can lead to increased phlegm formation due to an overloading of the respiratory tract.

Conclusion:

As far as we know, there are still no measurements of the viral concentration in the performance airstream of wind players. However, it is known that playing wind

instruments requires an intensive exchange of air in the lungs and airways that, at times, demands high air pressures. To what extent the viral load is reduced by the air's pathway through the instrument is still unclear. Based on the latest measurements presented above, it appears that 2 meters/6.6 feet is a sufficient minimal distancing from the player, because no additional movement of indoor air during playing was detected at this distance during the tests. Therefore, the risk of droplet infection can be classified as very low, if the distancing protocol continues to be observed.

In addition, wind playing leads to the formation of condensation from the exhaled air flowing through the instrument, which is to be regarded as a further potentially virus-spreading material. We recommend avoiding the draining of condensation onto the floor and recommend instead disposing of it in a collection container or absorbent blotting paper. Furthermore, wind players should not blow through their instruments to clean them. Tests with the Bamberg Symphony Orchestra had shown that blowing through instruments led to even more extensive air movement than playing itself, even if the distance was clearly less than 2m here as well (Spahn et al. 2021). Nevertheless, blowing through instruments in ensemble situations should be avoided, if possible. Wind instruments should, if possible, be cleaned in separate rooms away from the teaching or rehearsal setting. In the event of contact with condensation or with the interior of the instrument (e.g., horn), great care must be taken to ensure a thorough hand hygiene protocol is followed (at least 30 seconds of hand cleaning, i.e., very thorough hand washing with soap or, if necessary, the use of a hand sanitizer).

5.2 Forms of Wind Instrument Playing

Individual lessons with wind players

In our opinion, the risk appears in principle comparable to that of singers taking individual lessons (see above), whereby the CO₂ emissions of wind players are higher than that of singers (Nusseck et al. 2020). Using CO₂ measurements to comply with the threshold standard of 800 ppm can be a valuable aid here in monitoring the effect of

ventilation protocols over the course of time. Above and beyond that, it also makes sense to us that educators and pupils wear Mouth-Nose-Protection (MNP or better yet FFP2/N95 masks), when they are not playing. We emphasize the correct use of masks based on the most current hygiene protocols.

Brass music ensembles

Wind ensembles can have different numbers of players depending on their instrumentation. Nevertheless, the number of players must always correspond to the currently applicable regulations pertaining to allowable group sizes. The currently valid regulations and the number of permitted people in rehearsals, appearances, etc. are currently set in step-by-step plans that are dependent upon incidence values. (See i.e. <https://www.baden-wuerttemberg.de/de/service/aktuelle-infos-zu-corona/aktuelle-corona-verordnung-des-landes-baden-wuerttemberg/>)

Even though a 2 G rule exists, it is still the case for the winter months to come that rehearsal rooms should be as large as possible (both concerning surface area and height of ceiling) and that airing takes place on a thorough and regular basis.

By playing and singing in large rooms – in addition to concert halls, church interiors should also be thought of in this case – the risk can be reduced further. During the summer season, there was a significant opportunity for playing outdoors. There is a great tradition for doing this in the field of wind music, e.g. (Open-air-concerts, bandstand concerts, small traditional folk music groups, Big Bands, Brass Bands). The same opportunity was only partially possible in the winter half of the year, although here too, for example, it is also common for tower brass and carnival ensembles to play outdoors during the cold season.

It is to be expected that aerosols spread faster outdoors, that the deactivation process of the pathogens is greatly sped up (UV, ozone, hydroxyl radicals, nitrogen oxides) and that in its overall effect the risk of infection is much lower.

3.2.3. Other instruments

Keyboard, string, plucked and percussion instruments

In our opinion, other instrumentalists are not under any increased risk from droplet infection or increased aerosol formation by playing music together when compared to other social situations, as long as they strictly adhere to the applicable protocols. The other known risks still apply. If many musicians are gathered in one room, the possible risk of infection via aerosols needs to be kept in mind. Therefore, from our point of view, the above listed measures apply (See p. 24 ff.), especially to ventilation (when room air measurements of CO₂ reach 800 ppm, and in rehearsal / lesson situations sufficient cross ventilation and complete room airing out occurs) and to distancing. The important factors on when a rehearsal or class space needs to be ventilated are the size of the room, the number of people in it and the work performed therein. Thorough hand washing is also of particular importance. In addition, vaccinations and – especially for children and teenagers – PCR testing strategies are also recommended here.

Keyboard instrumentalists

Pianists risk contact transmission if different pianists play the same instrument in succession. Before playing begins, all players should clean their hands for at least 30 seconds (i.e. by thoroughly washing one's hands with soap or, if necessary, using a hand sanitizer). In addition, in our view, the keys themselves should be disinfected with cleaning cloths before and after being played.

Key coverings made of plastic can be cleaned and disinfected with an ethyl alcohol-water mixture in a ratio of 70 parts to 30. It is important that the keys are not just sprayed, but first sprayed and then wiped off. However, no liquid should get into the spaces between the individual keys, as the wood will then absorb the moisture and swell up resulting in a mechanical malfunction.

In our opinion, care should be taken during collaborative/accompanied rehearsals to ensure that a minimum distance of 2 meters/6.6 feet is kept between the pianist and fellow musicians, including during coaching/rehearsals of wind players or singers, as it is not uncommon for spontaneous movements to occur when playing or singing, e.g. turning towards the accompanist. According to our measurements, there is no danger of droplets being transmitted through the air from a wind instrument and a singer's mouth at this distance from the pianist.

However, a possible infection from aerosols in the room cannot be ruled out. In the sense of the risk reduction measures described above, we view the wearing of face masks – in the context of mutual protection of third parties and self-protection of the players – as an important option for the accompanist and the instrumentalists/singers with whom they make music.

Chamber music ensemble / band

Even for smaller ensemble configurations of chamber music or wind groups, the options for risk reduction by means of *entrance screening coupled with vaccination and, if necessary, testing* and the optimization of *room-space / air-ventilation / duration parameters*, as well as the *individual protective measures* detailed in Section 2 above, should be strictly observed. Here too, it is very important to observe the distancing protocols to protect against droplet contamination. For complying with the distancing protocols requires great attention, and because physical closeness and social connection are an intuitive part of music-making situations, and since music is accompanied by movements around the body axis in space, we feel a radial distance of 2 meters/6.6 feet between people should be observed. In addition, when several people play music together in a closed room, the risk-reducing protocols against an aerosol infection apply. These are: using the largest sized rooms available (which is determined by the combined radial distancing of 2 meters/6.6 feet around each musician), regularly timed airing out of the rehearsal/performance space (via active ventilation of inside rooms with outside

air, determined by the results of CO₂ testing) and as a result thereof reducing the total rehearsal length.

Other musicians not playing a wind instrument in chamber music ensembles or wind chamber groups should also wear face masks, as described several times above, in order to reduce the risk of an aerosol-borne infection. In summer, we also recommend that these instrumental groupings seek out places outdoors for rehearsing and performing. Above and beyond that, special care must also be taken to ensure that there is no hand contact or touching of surfaces (e.g., by sharing music, etc.) during breaks. Regular and thorough hand washing is very important and touching the face and rubbing the eyes should be particularly avoided. Sneezing and coughing should be avoided as much as possible and caught in the crook of the elbow.

Orchestra / Big Band

In large groupings of musicians, such as an orchestra or big band, the risk-reducing measures described above are to be applied in accordance with the respective ensemble's situation.

When the risks from droplet transfer and/or aerosols are added up, the risk-reducing measures must be combined in such a way that risks can be kept to an absolute minimum. Regarding the transmission of droplets between the individual musicians, according to our test data from the Bamberg Symphony Orchestra and from other working groups, it can be assumed that at a (radial) distance of 2 meters/6.6 feet between the musicians – all wind players including the flute – no droplet transmission is to be expected.

Because virus-laden aerosols can potentially spread in closed rooms during rehearsals and concerts, we believe that the greatest possible risk reduction should be carried out by using a combination of measures.

In the orchestra or big band this should include regular ventilation (see p. 18 ff), as already described for ensembles and choir. Regularly ventilating the room when the CO₂ measurements fall below the Pettenkopf value (max. 800 ppm) is a valuable aid during the monitoring of the effect of ventilation plans. The use of rooms with an HVAC system

set at a corresponding room air exchange rate of approx. once every 6 hours can also be an important measure towards reducing risk. In referencing risk minimalization, it appears that playing outdoors is the least risky. (See also Systematic Risk Reduction). In addition, a face mask should be worn for your own protection and that of others. For wind instruments, appropriate cloth protection can be fitted over the bells. The question of the length of time, i.e. how long a rehearsal or concert lasts, also plays a role for the expected aerosol particle concentration in a room: during longer time periods the particle concentration can increase to higher values than in shorter time periods. This should be considered when planning rehearsals or concert productions. Sneezing and coughing should be avoided, as much as possible, and captured in the crook of the elbow.

4. Risk management

Quality management has long used the established method of risk management -- for example in industry -- when new risks arise. Individual ISO-standards were developed specifically for it (ISO 3100:2018). Effective risk management usually requires a precise risk analysis with an associated likelihood of occurrence and knowledge of the effectiveness of certain risk-reducing measures. We currently know somewhat more about how the SARS-CoV-2 is transmitted, but from our point of view many of the interconnections are not yet quantifiable in such a way that the risks can be clearly calculated numerically. This is especially true for the field of music. To enable individualized advising in the amateur music field, the State Ministry of Science, Research and Art of Baden-Württemberg set up a counseling center for those playing & singing under Corona pandemic conditions at the Freiburg Institute for Musicians' Medicine beginning July 2020. Using a contact form (<https://fim.mh-freiburg.de/beratung-amateurmusik/>) it is possible to get answers to questions regarding the latest state of scientific knowledge from the point of view of musicians' medicine. The experiences gathered from the extensive previous counseling activities can also be transferred to the professional sector - to concert halls, opera houses and theaters, as well as music schools. The consultations have proven their value by using differentiated analyses of the respective factual conditions and by searching for appropriate ways of reducing risk.

The most effective means of reducing risk in the fight against the Corona virus is by vaccination. In the few months since the end of December 2020, this measure has been shown clearly and significantly to reduce risk. While a residual risk of infection remains for those vaccinated, too – as for those who have recovered from the disease – these so-called breakthrough infections generally run their course with mild symptoms, or none at all. Moreover, if a 2 G concept is followed strictly, then a high reduction of risk still exists, as an individual who could potentially infect others through a breakthrough infection encounters a group of people who for their part are immunized and thus present

a very slight risk of becoming infected themselves. In the case of 2 G, therefore, only a minimized residual risk can be assumed. This line of logic is also taken into account in the current Corona regulation of the state of Baden-Württemberg of August 14, 2021. Thus, if the room's capacity does not allow this, the minimal distance can be waived while music is being performed, a concession allowed for the audience, too (observing 3 G rules) (<https://www.baden-wuerttemberg.de/de/service/aktuelle-infos-zu-corona/aktuelle-corona-verordnung-des-landes-baden-wuerttemberg/>). The above-mentioned measures of entrance screening of optimized room volumes and ventilation could represent an effective additional measure for concert audiences, too, provided they are carried out consistently.

If the 3 G rule is implemented, which states that persons who are vaccinated, recovered (from the virus) and recently tested are permitted to participate, then a PCR test is clearly recommended with regard to risk reduction, as this process delivers the highest quality as a test. In addition, for 3 G in rooms, the risk of infection can be further reduced by wearing FFP2 masks throughout the whole event.

As scientists, we want to help convert as many of these unknown variables of the equation into known variables as possible. Based on the latest research results and recommendations from the working groups in Freiburg, Weimar, Munich and Berlin, which were intensively involved with the topic, assessments of levels of risk and degrees of infection risk can be formed that are dependent upon the risk-reducing measures taken, as can be seen in Figure 3.

According to our assessment, when levels 1 & 2 are reached, the risk is reduced to such an extent that music can be performed while strictly observing the risk-reducing measures. If only level 3 can be reached, playing or singing is not advisable. Playing or singing is prohibited at level 4.

LEVEL 1	<ul style="list-style-type: none"> • Persons fully vaccinated • Persons fully recovered • Persons regularly tested & currently negative • No risk reducing measures necessary (minimal distancing, etc.) (e.g. Sport) 	Very High risk reduction
LEVEL 2	<ul style="list-style-type: none"> • Complying w/ minimum distancing (2m circle, and w/ distance to side of 1,5m, offset set up) • Outdoors • Inside spaces <ul style="list-style-type: none"> -- that are very large („Cathedral-like situations“) - w/ high air exchange rate (mechanical ventilation or intermittent airing out (CO₂ –Device max. 800 ppm) - wearing surgical masks when singing (N95, FFP2) - specific measures for Winds & Brass (bell coverings, condensation capture pads) 	High risk reduction
LEVEL 3	<ul style="list-style-type: none"> • Irregularities at entrance screening • Noncompliance with minimal distancing regulations (2m circle, w/ distance to the side of 1,5m), when there are too many people in a room • Insufficient ventilation or airing-out options 	High risk of infection
LEVEL 4	<ul style="list-style-type: none"> • Lack of risk awareness • No risk reducing measures taken 	Very High risk of infection

Figure 3: Four stage assessment of reducing the risk of infection dependent upon risk-producing measures. (Based on the risk matrix according to Nohl 2019).

In practice, in our view, an optimal risk management would currently look something like each institution developing its own risk management protocols for its own specific musical setting. It is to be expected that the higher and more effective the number of risk-reducing measures, and the greater the number of those vaccinated, the greater the reduction in infection risk will be.

In this, it must be clearly pointed out that according to the ALARP principle (**As Low As Reasonably Practicable**), a residual risk will remain that is currently still not yet clearly quantifiable.

The hope remains that in the near future the expression of culture will gradually become possible again for artists and the public, by and large without restrictions.

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