Risk assessment of a coronavirus infection in the field of music 2nd update from May 19, 2020

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CONTENT

PREAMBLE

Since the first risk assessment published on April 25, 2020, further questions have been raised due to the dynamic situation of the corona pandemic. With the gradual loosening of the so-called lockdown since May 6th, 2020 - which also varies depending on the federal state - the questions from the field of professional music and amateur music are becoming more and more pressing, how and when musical activities can be continued. These relate to church singing in church services as well as organised forms of singing and playing music in amateur music as well as the professional music practice of orchestras, choirs, bands and ensembles in theaters, concert and opera houses and at other venues.

There are common and similar questions regarding the musical genres. Singing and instrumental lessons at music schools and other educational institutions are of particular importance.

With the expansion of the number of people, which according to the framework is allowed to gather in some federal states, group formations are now coming into focus when making music in orchestras, big bands and choirs. This increases the complexity of the questions to be discussed. Especially for the professional musicians there are questions of comparability with other work situations, for example to what extent the risk of infection when working in an open-plan office differs from the rehearsal work of an orchestra. The prospect of re-admission of the public, which is promised in individual states, also provides further questions.

Fundamentally, musicians are subject to the regulations applicable nationwide and in the individual federal states (meetings, contacts, minimum distance and mouth-nose protection (MNS)), which are specified in the ministries and with the health authorities (as well as possible other competent authorities and providers) statutory accident insurance). It is a major challenge to develop appropriate recommendations for specific and different situations in professional and amateur music as well as in classical and popular music. In this context, technical assessments, such as this one, are intended to provide pointers for decisions to be taken which have to be taken elsewhere - at the political and institutional level.

The first scientific studies and expert discussions among experts have emerged in the past few weeks. There are also current risk assessments for musicians and singers from various positions (including Charité (Mürbe et al. And Willich et al.), DGfMM (Firle et al.), Kähler & Hain, and the Health Working Group and prophylaxis of the German Orchestra Association (DOV) with commentary by the Association of German Operators and Company Doctors VDBW AG Stages and Orchestra (Böckelmann et al.).

We as authors endeavour to include scientific results in our assessment as fully as possible according to the current status. The aim remains to adapt the assessments made on the basis of the latest scientific results and to achieve a consensus on them.

In our risk assessment, we include the results of the study by wind players and singers, which was initiated by the Bamberg Symphony Orchestra and performed on May 5th, 2020 and in which the authors of the FIM were involved. The company Tintschl BioEnergie- und Strömungstechnik AG was commissioned for the measurements. All wind instruments common to the orchestra, as well as the recorder and saxophone as well as singers (classical singing and popular singing styles) were included in the study. Both qualitative tests for flow visualisation and quantitative measurements of air velocities at different intervals were carried out. The presentation of the measurement results and their discussion will be published in a further update.

In the areas in which no scientific knowledge is yet available, the explanations continue to represent technical assessments from the point of view of the authors. The paper at hand here is therefore still a snapshot, which in the further course will be based on the latest status of existing regulations and new ones scientific knowledge will be reviewed and adjusted.

In order to increase the quality and reliability of the risk assessment at hand, we have an interdisciplinary working group at the University Medical Center Freiburg with colleagues from the Institute for Infection Prevention and Hospital Hygiene (head Prof. Dr. med. H. Grundmann), Prof. Dr. med. Hartmut Hengel (Medical Director of the Institute of Virology) and Prof. Dr. med. Hartmut Bürkle (Medical Director of the Clinic for Anaesthesiology and Intensive Care Medicine). The colleagues mentioned helped shape and review this paper from their respective specialist perspective.

Since the outbreak of the corona pandemic, we have all had increasing experience regarding the epidemiologically important factors in the spread of SARS-CoV-2. The Robert Koch Institute and politics in Germany have made it clear from the start that the aim of the measures to be taken is to slow down and reduce the spread of infections. The guiding principle for the measures is to reduce the risk of infection with SARS-CoV-2 as much as possible. From our point of view, a risk assessment with regard to specific questions of music practice should therefore be based on the additional risk that arises from music practice. This orientation towards existing general standards seems important to us in order to enable political decision-makers to derive appropriate recommendations for action in the music field.

The risk assessment presented here pursues the concept of risk management with the aim of identifying specific risks in the field of music and at the same time offering risk-reducing measures. This could make it flexible. The respective musicians and music situations are adapted to risk management concepts and the questions related to the practice of music are appropriately integrated into the overall social framework.

In terms of flexible risk adaptation, it would be possible to differentiate more strongly between infection and disease risk in the future and to take different precautionary measures according to the disposition of the musicians (previous illnesses, age, etc.).

The local and temporal epidemiological situation (e.g. in a city or municipality) could also be taken into account for strategies to prevent infections when making music together. For example, better assess the collective risk of a choir rehearsal in the future using a COVID-19 tracing app - which is currently still under development.

Even if there are currently no sufficient foundations and tools for such a differentiated risk adaptation for society as a whole and in the field of music, the authors of the present paper try to take a first step toward that.

1. Transmission paths of SARS-CoV-2

Basic information

The main transmission of viruses that cause respiratory infections is generally via droplets and aerosols that arise when coughing and sneezing, and through the mucous membranes of the nose, mouth and deep respiratory tract when inhaled and, if necessary, via the conjunctiva of the eye. In this context, droplets are to be understood as larger particles (diameter of more than 5 micrometers). Sometimes they can be so large that they are visible when you cough or sneeze and can be felt on the skin. An aerosol (artificial word from ancient Greek ἀήρ, German 'air' and Latin solutio 'solution') is a heterogeneous mixture of very small suspended particles in a gas (diameter of less than 5 micrometers) that are not visible without technical aids. A Finnish working group from Aalto University in Helsinki around Ville Vuorinen carried out a computer simulation for the spread of aerosols in a closed room (supermarket) (Vuorinen et al. 2020). If an infected person emits viruses when coughing, the simulation assumes that the viruses can still be detected in the air after several minutes, even if the sick person has already left. Other people can then inhale the viruses in the air.

The viruses also get onto surfaces from which they can be transmitted by touching these contaminated surfaces with their hands, which then touch the face without being cleaned - provided that they have retained their ability to infect up to this point (contact transmission). The transmission paths are shown schematically in Figure 1.

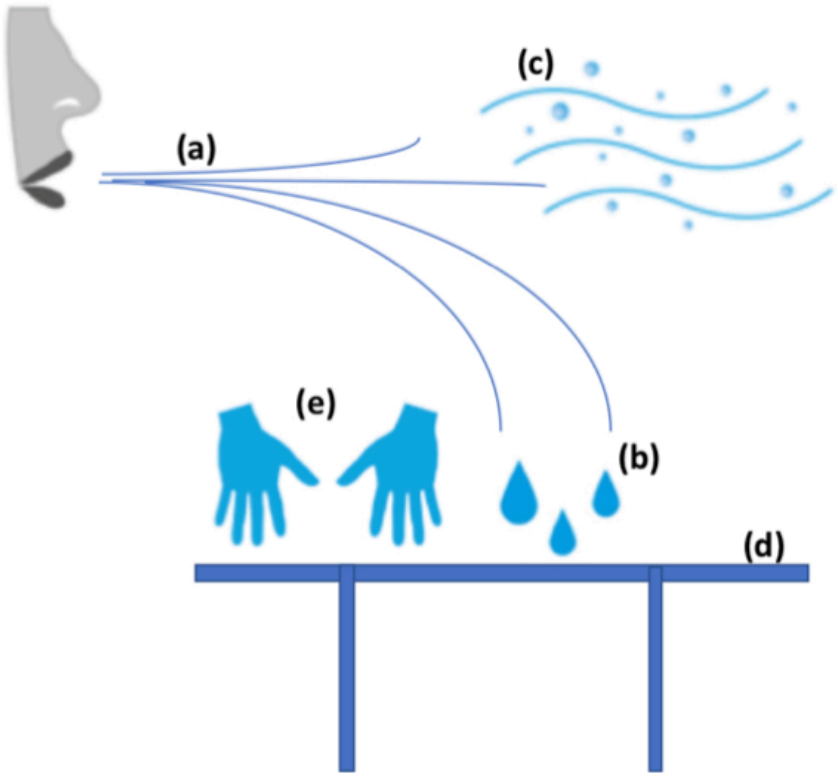

Fig. 1: Schematic representation of the possible transmission paths. With the exhaled air (a) droplets (b) and aerosols (c) get into the environment. The droplets can get on surfaces (e.g. a table (d)). From there they can be picked up by the hands (e). If the hands then make contact with the mouth,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

According to current knowledge, the spread of the corona virus (scientific name: SARS-CoV-2) as a trigger of the COVID-19 disease can take place via the route of droplet infection or via aerosols (Meselson et al. 2020).

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

Contact transmission of the virus is also possible. A transmission through contaminated surfaces cannot be ruled out, particularly 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). The extent to which an infection via the eyes is likely here cannot yet be conclusively assessed (Zhou et al. 2020).

In addition to the air we breathe, saliva and respiratory secretions should also be mentioned as relevant other 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 in these areas suffer from COVID-19 because they carry out endoscopic examinations and interventions in the mouth and throat area and may therefore have had intensive contact with all of these three types of transmission (German ENT Society 2020; Ruthberg et al. 2020).

2. Specific information about SARS-CoV-2

2.1 Systemic options for risk reduction in the music field

Before a vocal- and instrument-specific as well as setting-specific risk assessment takes place, systemic possibilities of risk reduction should be put in front, which can be applied in the music field. From our point of view, these play a decisive role, especially for formations with a larger number of people (choir, orchestra, big band).

The following Figure 2 gives an overview of possible measures for risk reduction. We see measures in three areas as meaningful here:

a.) In-coming control
b.) Parameters air / space / duration
c.) Individual protective measures

The areas a.) And c.) can be assigned to behavior prevention, area b.) Can be assigned to ratio prevention.

SYSTEMIC POSSIBILITIES OF RISK REDUCTION IN THE MUSIC AREA

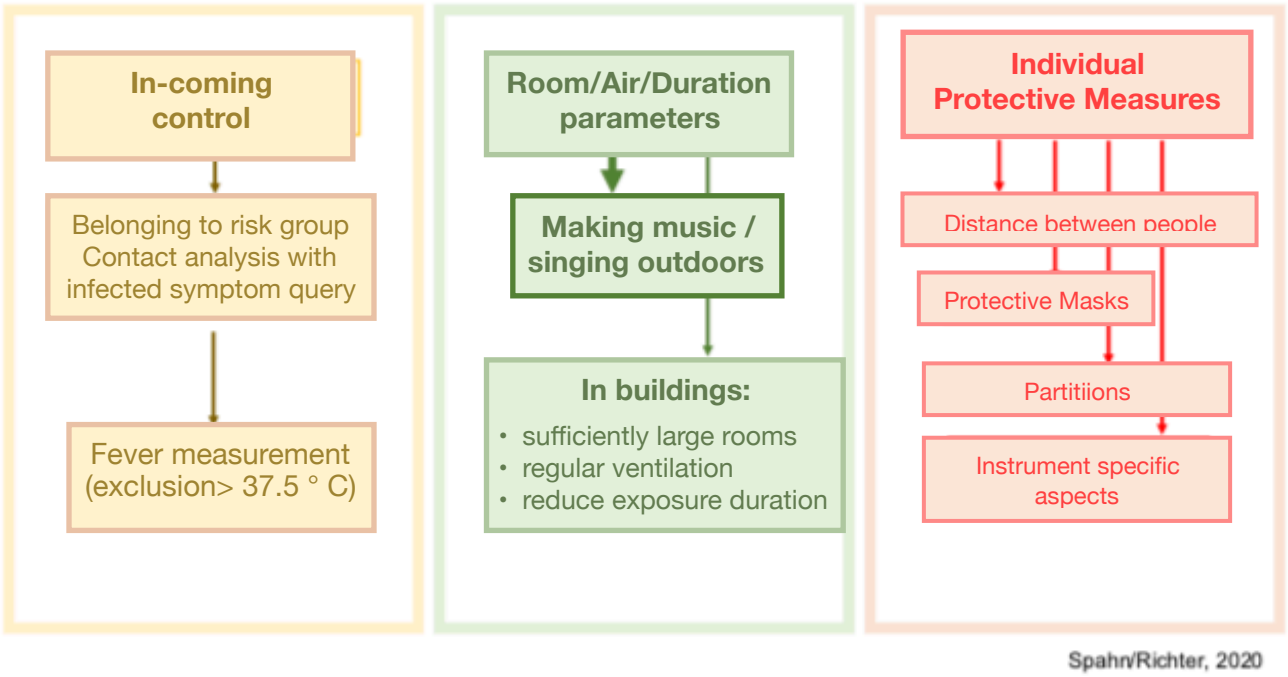

Fig. 2: Overview of systemic measures for risk reduction in the music field

a.) In-coming control
An in-coming control can include the collection and intensive control of several relevant features:

• An increased health hazard can be listed after the previous illnesses RKI can be assessed (RKI list of risk groups for severe courses).

• The assessment of the risk of being a virus carrier based on a personal contact analysis for the previous 5-6 days and the clarification as to whether symptoms suspect COVID-19 are present can be based on standardised questions (as a questionnaire or App2) regulate and the self-protection and external protection will increasingly improve in the future.

• Musicians in all areas of music should pay strict attention to non-specific disease symptoms such as fever plus respiratory complaints (dry cough, catarrh) or, in the case of more typical symptoms such as the acute loss of smell and taste function, to avoid any contact with other musicians until the SARS-CoV-2 PCR examination of the nasopharyngeal smear excludes the infection.
In the event of a proven infection, entry from another country or contact with a person infected with corona, the currently valid quarantine rules must be observed. If symptoms occur, contact your family doctor in any case. In the case of music lessons for children and adolescents, the legal guardians should also be given intensive information that they should not send their children to class at the first sign of suspected corona or mild symptoms. Students should also be made aware of this fact. This also applies analogously to educators who should not give lessons under these circumstances. For older or people at risk of previous illnesses (see risk list of the RKI) also currently apply particularly strict precautionary measures in the area of active music practice.

- Another possible measure, which is financially favourable and practicable, is temperature measurement as an additional screening 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, uses temperature measurement as a screening method for input screening e.g. No longer recommended

at airports, as only 42% of those infected in Germany had an elevated temperature (> 37.5 °) (Epidemiological Bulletin RKI 20/2020). Asymptomatic, fever-free virus eliminators cannot be measured using temperature measurement.

Both a standardised survey and fever measurement could improve the musicians' attention with regard to the hazard aspects and increase compliance when protective measures are carried out. The standardised survey is also part of the hygiene concept for the elective treatment of outpatients since the gradual opening of the clinics from 4.05.2020, as it is carried out at the University Hospital Freiburg. These simple measures are practical in terms of expenditure and are very well received. For the professional music sector (operas, concerts, theater), detailed hygiene concepts could also be used, which depending on the facility would have to be developed and checked by the company doctors (Böckelmann et al. 2020). These concepts could be based on existing concepts in professional sports.

b.) Room / air / duration parameters
The epidemiological findings from the course of the SARS-CoV-2 pandemic already show that room and air conditions and the duration of exposure to the accumulation 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).

Singing and playing music outdoors
Infections are likely to occur primarily 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 only one indication of an outdoor infection (Qian et al. 2020). It can be assumed that aerosols spread faster outdoors, the inactivation process of the pathogens is greatly accelerated (UV, ozone, hydroxyl radicals, nitrogen oxides) and the overall risk of infection is therefore much lower. If the minimum distance is observed, the risk of singing and playing music outdoors can therefore be assessed as very low.

The open air situation is therefore the first choice for making music with several people. Especially in view of the fact that the coming weeks and months, in which the gradual opening will take place, are the summer months, making music outdoors seems practical and even particularly attractive. There is a long cultural tradition here, just think of the ancient amphitheater. The term chorus (ancient Greek χορός choros) originally referred to the dance floor of an amphitheater in which people also sang. Traditionally, brass music in rural areas also takes place outdoors. Outdoor concerts are the predominant setting in pop and rock. For the audience, the prevailing rules of the assembly must be observed or creative solutions (e.g. so-called concert promenades, i.e. changing concerts) must be found.

Singing and making music in closed rooms
• *Ventilation*: Finds singing and playing music in closed rooms natural ventilation instead, according to previous experience, regular and thorough ventilation seems to be an important factor in risk reduction. If the rooms have mechanical ventilation (ventilation and air conditioning systems, air handling systems), a reduced risk of infection from aerosols can be assumed (with natural ventilation, aerosols themselves are affected by the air change in the range of approx. 0.5–2 / h closed windows removed, e.g. for air conditioning systems in concert halls or halls the air exchange rate is approx. 4-8 / h).

• *Room size*: The size of the room and the number of rooms people and the length of time they are in a closed room seem to play an important role (Tellier 2006). A larger number of people who stayed in confined and poorly ventilated rooms for a long time seem to have favoured the spread during the outbreaks in Ischgl and Heinsberg. In relation to making music together, very large spaces such as Church rooms, concert halls or city halls can also be used as rehearsal rooms.

- *Sampling time*: In addition to the sufficient room size, short rehearsal phases (e.g. 15 minutes, see also Robert Koch Institute, as of April 16, 2020 contact person tracking for respiratory diseases caused by the coronavirus SARS-CoV-2) with breaks in which shock ventilation is likely to be effective for risk reducing.

c.) Individual protective measures

• *Mouth-nose protection*: Wearing a mouth-nose-protection (MNS) (or a mouth-nose-cover) represents an important possibility for risk reduction, especially in the music field, from our point of view. that it is used even though when singing or playing a string, plucked or keyboard instrument can spontaneously be felt as inappropriate or disturbing. When wearing MNS or masks (filtering half-masks), an infectiological point of view is used to distinguish whether a person is to be protected from infection by droplets or aerosols from other people (self-protection) or whether the spread of infectious material by one person to another (third-party protection) is the aim.
The material of the medical face masks, type II (according to DIN EN 14683: 2019- 6), which are currently readily available as MNS, absorbs ≥92% of the particles ≥3 μm in diameter. Thus, they represent a sensible measure for external protection, however, they also offer relevant intrinsic protection (according to IuK measurements, they retain, for example, particles ≥0.5 μm to approx. 80–90% and particles ≥0.3 μm to approx. 70–80%). However, the correct mask fit also plays an important role here, especially when forced exhalation, air particles can escape laterally past the masks (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).

- *Distance rule*: It is very important to us to comply with the distance rule also in the music business to protect against droplet contamination. Since compliance with them requires great attention, physical closeness and social connection are an intuitive part of music situations, and since singing and playing music do not take place from a rigid body position, but rather require a certain movement in space, we believe that the distance between people should be 2 meters. By maintaining a radial distance of 2 meters for an individual, a number of people in a closed room can simultaneously achieve a positive additional effect that, according to this rule, only a few musicians can stay in small rooms. With larger formations, a larger room size is necessary if this rule is observed. A minimum radial distance of 2 meters can help to reduce not only the risk of droplet transmission, but also the risk of an increased build-up of aerosols indoors. However, compliance with the distance rule does not replace regular ventilation and the reduction in exposure times.

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

2.2 Vocal and instrument-specific risk assessment

2.2.1 Vocals

General risk assessment of singing
As already described, a distinction must be made between the transmission pathways of SARS-CoV-2 between the risk of infection from droplets containing viruses and aerosols containing viruses. In addition, there are the important transmission paths via hand / nose / mouth contact and, if necessary, hand / eye contact.

Droplets: Due to their size and weight, droplets sink quickly to the ground and reach a maximum distance of 1 meter. The distance rule of 1.5 meters is based on this in everyday situations (shops, offices, etc.).

Is there an increased risk of droplet infection when singing?
Voice physiology has long described that during phonation (sound production when singing) no significant additional air movement occurs before the mouth of the singer, since sound waves propagate physically without flow: the flame of a burning candle does not move in front of a singer's mouth, itself when he sings loudly. This observation could be confirmed by the measurements by the Bamberg Symphony Orchestra with three singers. The artificial fog directed directly in front of the singer's mouth was not visibly distracted by singing in different pitches and volumes and styles. With forced articulation with plosive sounds, slight turbulence was observed in the close range. When measuring the air speed by sensors at a distance of 2 meters from the singing, however, no air movement could be measured. This distance of 2 meters can thus be viewed as a safety distance for droplet infection even with forced articulation.

Aerosols: Reproductive pathogens are integrated into aerosols in the airways, e.g. the chickenpox virus, influenza viruses, measles virus, mycobacterium tuberculosis and obviously also SARS-CoV-2.
It has been shown that aerosol formation increases with increasing volume when speaking (Asadi et al. 2019). No scientific studies are available on aerosols while singing. When aerosols emerge from the mouth opening, it is to be expected that these will rise due to the lower specific density (approx. 37 ° C and> 95% relative humidity) and then mix with the room air. Sedimentation is practically irrelevant for aerosols below a particle size of approx. 4 µm.

Is there an increased danger from aerosols when singing?
Basically, it must be assumed that singing as well as resting breathing or speaking can produce aerosols that can transmit viruses (Fabian et al. 2019). Overall, the measurement of aerosols is a technical challenge.

Inhalation
To what extent there is an increased risk of infection from singing through deep inhalation has not yet been scientifically investigated.

Slime production
In the case of singers, slime productions can also occur outside of sound production. On the one hand, it is not uncommon to observe when playing in or singing in that more mucus is produced, which is then removed from the respiratory system by coughing or clearing the throat. Likewise, prolonged play can lead to increased mucus formation due to overloading the respiratory tract.

Conclusion General risk assessment with regard to the singing process

Based on the relationships and results shown, we assume that singing does not increase the risk of droplet transmission if a distance of 2 meters is maintained. Based on the latest measurement results, it does not appear necessary to over-fill the distance by 3-5 meters, as we had formulated in the first risk assessment from April 25, 2020. The extent to which aerosol formation and diffusion is specifically changed by singing is still difficult to assess at present. It is also still unclear what influence deep inhalation while singing has on a possible infection. As a consequence of the existing knowledge, we believe that necessary protective measures must be proposed. These are described in the individual forms and settings in which singing occurs.

Forms of singing

Individual singing lessons

With solo singing there is a deep inhalation and exhalation during sound production. To our knowledge, the extent to which this results in an increased risk of infection has not yet been scientifically investigated. Even if the direct air flow is not strong in singing phonation, as our latest measurements have been able to confirm, it can be assumed that, during singing, viruses are spread through aerosols. 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 by droplets can also be reduced by installing plastic partitions. Here, noise protection screens already available in some institutions could be used as makeshift barriers. Furthermore, it makes sense to us that pedagogues wear additional mouth and nose protection (MNS) during the individual lessons when the students sing. If protective masks for the non-medical area are available, wearing an FFP-2 mask can further reduce the risk of infection in terms of self-protection.

From our point of view, under strict observance of the safety measures (according to the latest measurements, in particular a distance of 2 meters (see above)) and the presence of the spatial requirements (sufficient room size, ventilation breaks every 15 minutes and especially between the individual students) Reduce risks in individual lessons. However, it cannot be inferred from this updated risk assessment that teachers or teaching staff may be obliged to give individual classes as face-to-face classes or to take part in them. In our opinion, if the structural and organizational requirements are not met or the people involved belong to a risk group, teaching should not be done as face-to-face teaching, but digitally.

Choir singing

When choral singing there are basically the characteristics of the singing process described above. Since the formation of aerosols by each singer must be assumed, it can be assumed that when a large number of people accumulate, aerosols containing viruses will accumulate in a higher concentration in the enclosed space (Liu et al. 2020). The ventilation quality also plays an important role here (Li et al., 2020). The question of the duration, i.e. how long a choir exposure lasts, also plays a role for the expected particle concentration of the aerosol in a room: in longer periods the particle concentration can rise to higher values than in shorter ones.

The spread of SARS-CoV-2 infections after choir rehearsals from different choirs and services has been reported several times. On May 12th was reported in a scientific publication for one of these outbreaks in a choir in the United States (Skagit County, Washington) (Hamner et al. 2020). The choir reported to the health authorities on March 17, 2020 that the infection rate was high. The choir rehearsal, which presumably leads to infection with a high infection rate occurred, took place on March 10th, 2020. Of the 61 choir members who took part in the rehearsal on 10.03. participated, 53 fell ill, three had to be treated in hospital, two died. The median age of the singers was 69 years (range = 31–83), the three inpatients had two or more known medical conditions. Infection via aerosols is discussed in the publication as a likely source of infection. However, other influencing factors are also critically examined. The distances between the individual singers were small at 6-10

inches (about 15-25 cm) between the chairs. The duration of the entire exposure was approximately 2 1⁄2 hours. There was a 15 minute break snack. In addition, the alleged index person who was the primary source of infection on March 10, is considered, at the time of this exposure visit since March 7th. Symptoms, the person also had on 3.03. participated in the rehearsal.

In order to reduce the risk of infection from aerosols in the choir situation, mouth and nose protection can be worn, as already explained above. On the other hand, singing in very large rooms, such as concert halls or church rooms, appears to be very cheap. Regular ventilation of the room approximately every 15 minutes or the use of rooms with an HVAC system are important measures for risk reduction. In terms of risk minimisation, it seems most beneficial if you can sing outdoors (see also Systemic Risk Reduction).

Furthermore, in rehearsal practice, a division of the probationary periods into short sections of 15 minutes can help minimise risk. To switch off a droplet transmission in the choir, the usual distance rule of social distancing must also be observed during breaks, MNS should also be worn to protect against droplet transmission.

In our view, care must also be taken to ensure that there are no hand contacts or contacts over surfaces (e.g. by passing on notes, etc.) in break situations. Regular thorough hand washing is very important, especially touching the face and rubbing the eyes should be avoided. A general further risk reduction is personal in-coming control (see above). Sneezing and coughing should be avoided as far as possible and caught in the crook of the elbow.

Singing in the service
Community chant appears possible if the distance rule of 2 meters is observed and MNS is worn, since it can be assumed that singing does not increase the risk of infection compared to speaking. In addition, services usually take place in large to very large rooms.

2.2.2 WIND INSTRUMENTS

Risk assessment regarding the wind instrument play

With the exception of flute instruments (recorder and flute), experienced players of wind instruments do not let air out at the contact between the player's mouth and the respective mouthpiece (cauldron, single and double reed). With some wind instruments, air comes out of the flaps at certain tones, wind instruments have a sound opening e.g. in the form of a funnel. The wind instruments are to be considered individually because of their special features.

As a common feature - apart from the flutes - it can be stated that the sound is created by vibrations of the lips of the mouth (brass instruments) or interrupted by pipes or leaves in the mouthpiece (reed instruments among the woodwind instruments). Similar to singing, only small amounts of air per unit of time flow out of the instrument's horn in wind instruments. The current measurements with the Bamberg Symphony Orchestra by Dipl. Ing. Schubert from Tintschl support these assumptions. Due to the transmission pathways of SARS-CoV-2 described above, a distinction must be made between the potential risk of infection from virus-containing droplets and virus-containing aerosols when blowing. In addition, there are the important transmission paths via hand contact and hand / eye contact.

Droplets: Due to their size and weight, droplets sink quickly to the ground and reach a maximum distance of 1 meter. The distance rule of 1.5 meters is based on this in everyday situations (shops, offices, etc.).

Is there an increased risk of droplet infection when playing a wind instrument?
Because of the contact between the player and the respective mouthpiece in brass instruments and woodwind instruments with a simple reed (Clarinet and saxophone) and double reed (oboe, bassoon) when mastering the instrument no air escapes, no droplets can be released from the player's mouth when playing directly to the environment. 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 on the mouthpiece and droplets can be released. The measurements at the Bamberg Symphony Orchestra show that with regard to the air speed parameter, no air movement could be measured at the sensors, which were placed in the extension of the mouthpiece in 2 meters. Therefore, transmission by droplet infection is very unlikely at this distance. The lips of the recorder enclose the beak of the flute so that no droplets can get into the surroundings. On the other hand, droplets could form when the air flow is broken at the labium of the head piece. In the measurements by the Bamberg Symphony Orchestra, air movements when playing the recorder in the area of the labium were no longer measurable at a distance of 1.5 meters. Therefore, transmission by droplet infection is very unlikely at this distance.

Condensed water: Condensed water is created when warm, moist breathing air in the instrument, whose inner walls are significantly colder, condenses as water drops. During this process, any aerosols contained are greatly reduced (air washer principle). If it is breathing air from a virus carrier, the question arises as to whether and to what extent this condensed water, which has to be drained from brass instruments during breaks, contains viruses and is therefore potentially infectious. Measurements regarding the viral load in the condensed water are still pending.
Aerosols: When aerosols emerge from the mouth opening, they rise due to their low specific weight of the exhaled air. They spread out in space, with sedimentation no longer playing a practical role. A reduction can only occur as a result of the dilution with the air volume in the respective room and through the given air change.

Is there an increased risk of aerosols when playing wind instruments?
When playing the wind instruments - except for the flute - aerosols do not reach the room air directly from the mouth opening. They get into the instrument body and through open flaps and / or

the horn into the environment. A distinction must be made here between the possible exit points of the wind instruments. In brass instruments, air exits through the bell. With woodwind instruments, all side holes are closed only at the lowest tone of the respective instrument, so that only in this case does the air escape from the bell. Exceptions to this are the oboe and the cor anglais, in which air escapes through the last open side hole even when the instrument is deepest. In addition, with woodwind instruments, the air outlet through the first open side hole changes depending on the pitch played.

Even when playing the flute and recorder, aerosol formation occurs exclusively in the airways. For the flute, the air flow can be compared to an exhaled flow. The air flow is deflected here in the sense of the *Coanda* effect. With the recorder, the lips enclose the beak of the flute and the air flow is broken at the labium of the headpiece.

It can be assumed physically that in every wind instrument there are surface contacts with aerosol particles in which they are adsorbed, i.e. that the instruments basically reduce the particle concentration of the given aerosol. The longer the airway in the instrument, the smaller the cross-sections and the more curvatures the greater the effect. The effect affects all particle sizes, but it is higher for larger particles than for smaller particles, e.g. viruses. As described above, the question arises as to what extent the instrument also acts as a filter for aerosols (due to condensation of air humidity and due to surface contact). Measurements are still pending.

As long as no clear results are available, some authors (cf.Kähler & Hain; Willich et al.) recommend using either a protection made of transparent material or tightly woven silk scarves (including pop protection) in front of the bell of the instruments for brass instruments. Until further clarification of the question, this could result in a reduction of possibly escaping aerosols. A covering over the bell in woodwind instruments seems less expedient for the reasons mentioned above.

The extent to which there is an increased risk of infection due to deep inhalation has not yet been scientifically investigated.

From the recipient's side, the question arises as to what extent virus-containing aerosols are absorbed in greater amounts by deep and often rapid inhalation when playing wind instruments, and to what extent viruses get into the respiratory system. No scientific studies have been carried out here to date.

With brass players, slime productions can also occur outside of sound production. On the one hand, it is not uncommon to observe when importing that more mucus is produced, which is then removed from the respiratory system by coughing or clearing the throat. Likewise, prolonged play can lead to increased mucus formation due to overloading the respiratory tract.

Conclusion General risk assessment of wind instruments
As far as we know, there are currently no measurements of the virus concentration in the blow-out air for wind players. However, it is known that playing the wind instruments requires an intensive exchange of air in the lungs and airways with sometimes high air pressures. The extent to which the viral load is reduced by the airway in the instrument is currently unclear. Based on the latest measurement results, it does not appear necessary to over-fill the distance by 3-5 meters, as we had formulated in the first risk assessment from April 25, 2020. 2 meters seem to be sufficient as a minimum distance, because in this there was no additional room air movement due to the distance during the measurements and the risk of droplet infection if the distance was observed is therefore very low.

In addition, there is the formation of condensed water from the exhaled air in the instrument, which can be regarded as another potentially virus-spreading material. Here we recommend avoiding the draining of condensed water on floors and disposing of it in a collecting container or absorbent

blotting paper. Furthermore, wind players should not blow through the instruments for cleaning. Wind instruments should, if possible, be cleaned in separate rooms outside of the teaching or music settings. In the event of contact with condensed water or with the interior of the instrument (e.g. horn), care must be taken to ensure that hand hygiene is particularly thorough (at least 30 seconds of hand cleaning, i.e. very thorough hand washing with soap or, if necessary, use of a hand disinfectant).

Forms of wind instrument playing

Individual lessons with wind players
In our opinion, the risk basically seems comparable to that of singers in individual lessons (see above).
In addition, it makes sense to us that educators and pupils wear mouth-nose protection (MNS) during the individual lessons when they are not playing. Here you have to pay attention to the correct handling of the masks according to the hygiene rules. If protective masks are available for the non-medical area, wearing an FFP-2 mask could further reduce the risk of infection.

Wind ensembles
Wind ensembles can have different numbers of players depending on the formation. The number of contributors must always correspond to the currently applicable regulations. Even with smaller ensembles, a minimum distance of 2 meters should be maintained according to the latest measurements, since at this distance no additional room air movement could be determined by playing. Rehearsal rooms should be as large as possible and ventilation should be thorough and regular.

Since compliance with the distance rule is a very important measure (see section 2 c.)), Making music in large rooms - in addition to concert halls, church rooms are also to be considered here - can further reduce the risk. In the summer season we see an important opportunity to play outdoors. There is a great tradition for this in the field of brass music.

It can be assumed that aerosols spread faster outdoors, the inactivation process of the pathogens is greatly accelerated (UV, ozone, hydroxyl radicals, nitrogen oxides) and the overall risk of infection is therefore much lower. If the minimum distance for wind ensembles is observed, the risk can be assessed as very low.

2.2.3 OTHER INSTRUMENTS

Keyboard, string, plucking, percussion instruments
From our point of view, with all other instrumentalists there is no increased risk from the practice of music compared to other social situations with regard to the question of droplet infection or increased aerosol formation, provided that the applicable rules are strictly observed. The known risks apply. If there are several musicians in one room, the risk of possible contamination by aerosols must be taken into account. In our view, the measures listed above (see Paragraph 2 b.) Therefore apply, in particular ventilation (after 15 minutes of rehearsal / lesson ventilation,) and sufficient room size and distance. Thorough hand cleaning is of particular importance.

Keyboard instrumentalists
With pianists, the risk of contact transfer plays a role if different pianists play the same instrument in succession. Before the game begins, every player must therefore perform a hand wash for at least 30 seconds (i.e. very thorough hand washing with soap or, if necessary, use of a hand disinfectant). In addition, from our point of view, the keys themselves should be cleaned with cleaning cloths before and after playing a person.

In our opinion, when performing repetition, care should be taken to ensure that a distance of 2 meters between the pianist and the fellow players, including when performing repetitions by wind players or singers, should be taken, as it is not uncommon for spontaneous movements to occur when making music Turn to the accompanist. According to our measurements, there is no fear of droplets being transmitted by air movements from the wind instrument and the singer's mouth at this distance from the pianist.

However, possible contamination by aerosols in the room cannot be ruled out. In the sense of the risk reduction measures described above, we see the wearing of MNS in the sense of mutual external and self-protection of the players as an important possibility for the accompanist and the instrumentalists and singers with whom he / she makes music. For wind players, the risk reduction measures described above come into question.

String instruments, plucked instruments, drums
The transfer or sharing of instruments should be avoided if possible. As with the pianists, the risk of contact transmission can be reduced by cleaning hands and avoiding touching the face and eyes.

Chamber music ensemble / band
Even in smaller ensemble formations of chamber music or bands, the options for risk reduction through the incoming control, the optimisation of the parameters room / air / duration as well as the individual protective measures detailed in section 2 above should be observed. Here too, it is very important to comply with the distance rule to protect against droplet contamination. Since compliance with the distance rule requires great attention, physical closeness and social connection are an intuitive part in music situations, and since music is accompanied by movements around the body axis in space, the distance between people should be 2 meters in our view. In addition, when several people play music in a closed room, the risk-reducing protective factors for infection by aerosols apply. These are: rooms as large as possible (enforced by a radial distance of 2m around each musician), regular ventilation (after 15 minutes of rehearsal / instruction shock ventilation in closed rooms with natural ventilation) and a reduction in the total duration of the rehearsal.

In addition, in chamber music ensembles and bands, as described several times above, to reduce the risk of an aerosol-borne infection, musicians who do not play a wind instrument should wear mouth and nose protection (MNS).
In our view, care must also be taken to ensure that there are no hand contacts or contacts over surfaces (e.g. by passing on notes, etc.) in break situations. Regular, thorough hand washing is very important, especially touching the face and rubbing the eyes should be avoided. Sneezing and coughing should be avoided as far as possible and caught in the crook of the elbow.

Orchestra / big band
In large collections of musicians such as in the orchestra or in big bands, the measures described above for risk reduction are to be applied to the respective situation of the respective sound body. When the risks from droplet transfer and / or aerosols are summarised, the risk-reducing measures must be combined in such a way that the greatest possible risk minimisation can be achieved. With regard to the transmission of droplets between the individual musicians, according to the measurements by the Bamberg Symphony Orchestra and other working groups, it can be assumed that at a distance of 2 meters (radial) between the musicians - including the wind instrumentalists including the flute - not droplet transmission is to be expected.

However, there is no scientific evidence regarding the distribution of aerosols in closed rooms during rehearsals and concerts. As long as this is the case, we believe that the greatest possible risk reduction should be carried out through a combination of measures. This should be in orchestra or big band - as already described for ensemble and choir - including consist of regular ventilation (see paragraph 2 above). Regular ventilation of the room every 15 minutes or the use of rooms with an HVAC system are important measures for risk reduction. In terms of risk minimisation, it seems most beneficial if you can play outdoors (see also Systemic Risk Reduction). In addition, MNS

should be worn for external and internal protection. For wind instruments, as long as the filter effect of the instruments has not been proven, appropriate textile protection can be attached to the horns. The question of the length of time, i.e. how long a rehearsal or concert lasts, also plays a role for the expected particle concentration of the aerosol in a room: in longer periods the particle concentration can increase to higher values than in shorter ones. This should be taken into account during rehearsals or concert programs. Sneezing and coughing should be avoided as far as possible and caught in the crook of the elbow.

Especially with larger numbers of people, the situations outside of orchestral activity / band play an important role for a possible infection. It is particularly important to ensure that there is no hand contact or contact over surfaces (e.g. by passing on notes, etc.) in break situations. Regular, thorough hand washing is very important, especially touching the face and rubbing the eyes should be avoided.

The incoming control mentioned under the measures above could represent an effective additional measure if used consistently.

3. Risk management

Effective risk management usually requires a precise risk analysis with associated probability of occurrence and knowledge of how effective certain risk-reducing measures are. However, we currently do not know much about the transmission by the SARS-CoV-2, so risk management currently means an equation with many unknowns. This leaves room for the fact that different target perspectives (disease rate vs. preservation of the music culture) and personal attitudes (risk-averse or risk-averse) can lead to different recommendations for action. Each individual must be granted the right to decide what risk he or she is willing to take.

As scientists, we want to help convert as many unknown variables in the equation as possible into known variables.

In practice, from our point of view, optimal risk management would be such that each institution develops its own risk management for its specific music setting. It is to be expected that the higher the number of risk-reducing measures, the more the risk of infection can be reduced. This procedure should be accompanied by advice from the company doctors, health authorities, etc.
As long as we do not yet have a sufficiently scientifically sound basis, in case of doubt we have to overestimate rather than underestimate the possible risks. In this way, the overall risk of infection can be reduced as much as possible by combining risk-reducing measures. However, it must be clearly pointed out that according to the ALARP principle (As Low As Reasonably Practicable) a residual risk remains that is currently not quantifiable.

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