COVID Lux Update
- Mid-July 2020

Our original mid May summary and recommendation for Choral Singing in the era of COVID-19 is reproduced below. It may bear quick review before this update. A short section on Audience Considerations remains relevant.

As of 5/19 the US had suffered about 92K deaths attributable to the virus. In the next week or so it appears we will pass 140K. In May some areas of the country believed they would be spared contagion. Those areas especially in the SE and SW are being taught by the virus that it is indiscriminate. There is not yet a vaccine and treatment remains largely supportive. In short, little has changed in our milieu except the geographic locations of the most active contagion.

It is not our function here to examine the reasons that the US experience with the disease has so diverged from the European or Asian experience.
But there is, perhaps, some research in the last two months that speaks to the specific questions surrounding Choral Singing.

The reader can skip down to a summary update and references for the (current) bottom line, but there are two general concepts to do with discovering and implementing successful strategies to limit COVID-19 that are pertinent to the pace of research and the confidence in its implications. And we have been asked to touch on the prospects for Vaccination as well.

Two General Concepts:

Concept One is a distinction between the complexity of the SARS-CoV-2 virus itself (and the powerful tools we have for its study), and the much greater complexity of the disease COVID 19 for which tools are less powerful and our understanding inevitably more rudimentary.

For instance the virus was isolated and its entire genome determined within less than two weeks in January - an extraordinary feat considering, for instance, that it took more than 20 years to accomplish the same thing for Hepatitis C a generation ago. Having the viral gene sequence is of inestimable value in it's control, enabling close scrutiny of the process of infection - which viral proteins facilitate entry into the respiratory cell, which genes, if altered experimentally, reduce virus-related injury to cells maintained in the laboratory and so on. The advances in molecular biology over the last few decades are staggering.
And yet, the *disease* COVID-19 in real people in the real world has all the additional complexity of humans and society: a genetic diversity among patients; differences in underlying health problems and age, variables including the duration of contact and relative proximity in contagion, the immune response itself as well as the inevitable heterogeneity of human responses to unwelcome medical advice.

So on the one hand never has a novel pathogen been so quickly identified and sequenced and made available for international study. And yet after 6 months of disease we still don't know the proportions of people infected by surface contact, vs droplet exposure or aerosol. And we still do not know why some people get so much sicker than others.
This is frustrating but not entirely surprising - you can study the *virus* in the isolation of a laboratory. But how COULD you ethically get enough people to stand 1 and 3 and 5 and 10 feet from a known infected source, breathing in the cough- and sneeze-filled air in order to REALLY pin down the safety impact of distancing?

Thus lab work - such as vaccine development - proceeds at lightning speed, but the complexity of infectious dose and its delivery, immune response and its mediation, post-infectious antibodies and their duration and, eventually, the impact of vaccine - is mostly obtained retrospectively, depending upon organized observation of large numbers of people and advancing S L O W L Y…..We can be delighted at the occasional Aha! moment, but for the most part, advances in understanding and treatment of COVID-19 are likely to spool out over many months.

The second background concept worth noting is the ever-problematic decision as to when evidence is good enough to prompt policy.
A clinical decision is relatively easy when there is one patient and one doctor. If a hospitalized patient has a condition suspicious enough for Tuberculosis to prompt testing, then that patient would be placed in isolation for the several days it takes to get results. If TB is disproven then a couple of days of masks and isolation is not painful. Whereas if positive, exposure to others has already been halted .

But an intervention affecting millions of people means more complicated decisions with broad implications. Should you recommend masks when you know only that they 'probably' reduce disease spread, especially if supplies are inadequate for universal use? Will they provide a false sense of security (or be used improperly) such that other useful

interventions (like scrupulous hand washing) lapse and there is no net gain in safety? Should you remain agnostic only until the evidence is just 'pretty good" for an intervention or wait for absolute certainty? Early adoption risks subsequent revision and loss of both money and perhaps public confidence; late adoption could mean unnecessary risks to those who might have been spared infection by even imperfect interventions.…

The point is that reasonable people might disagree on policy implications of evolving research. Inevitably inconsistencies saps confidence in recommendations and presumably reduce compliance in turn making it that much more difficult to measure impact.

Our committee doesn't function as an apologist for the WHO or CDC or the Whitehouse or the Governor. No doubt serious retrospective review of 2020 will reveal mis-steps and missed opportunities. With an ever- evolving understanding of the disease, areas of greatest importance might well have been better anticipated and guidance provided with more clarity. We point out however that there really ARE significant obstacles to providing Certainty in policy and recommendations. So too in this Update, we are attempting to make the best of the data we have but conclusions are to some degree provisional and subject to change as we come to better understand this disease. We will append a note on the status of Vaccine Development below.

BackGround References:

A couple of non-technical but accurate and useful sources are provided for background:

https://english.elpais.com/spanish_news/2020-06-17/an-analysis-of-three-covid-19-outbreaks-how-they-happened-and-how-they-can-be-avoided.html?fbclid=IwAR2aK62cF9oRFrWfK3zgDy-1IWk89gXfKDZWWQuwaQQWylqYO8e752ScsDo

https://www.vox.com/science-and-health/2020/7/13/21315879/covid-19-airborne-who-aerosol-droplet-transmission

Mid July UPDATE:

1) The evidence for significant unwitting viral spread from asymptomatic and pre-symptomatic carriers has strengthened and with it the recognition that the identification and exclusion from public places of febrile or symptomatic folks will not allow a

safe public space. https://www.pnas.org/content/early/2020/07/02/2008373117?fbclid=IwAR082PkYckcDwPxJOlxjP-BEXkjZQ6IHMJ5anWYh8AY5FCv83qynx2e8ajzc and see https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions

2) The evidence for respiratory spread in droplet form is secure though with the caveat that the same proximity that permits it also provides space for fomites to transfer infection - a contaminated surface for instance. So it is very difficult to separate spread by respiratory droplets encountered during inhalation from virus encountered in droplets on a surface and transferred by hand to the respiratory tract. (https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions) Either way, masks are protective - see below. It is also worth noting that 2 meters may be further than the distance travelled by MOST droplets when they are the product of ordinary speech, but coughing and sneezing can send droplets 8 to ten meters and more. (JAMA. 2020;323(18):1837-1838. doi:10.1001/jama.2020.4756) Research cited in the May report suggests that for the purposes of pathogen projection, choral singing is more closely akin to coughing and sneezing than to ordinary talking.

3) The value of distancing and masks in day to day risk reduction is secure. We are speaking of homemade or 'surgical' masks here which probably protect others more than they do the wearers. https://www.cdc.gov/mmwr/volumes/69/wr/mm6928e2.htm?s_cid=mm6928e2_e&deliveryName=USCDC_921-DM32906 Indeed reference 14 in the following citation, an analysis originating at Goldman Sachs suggests a 15% increase in Mask use could save a trillion dollars. https://jamanetwork.com/journals/jama/fullarticle/2768532 The addition of face shields has been recently suggested by the CDC and implemented as part of PPE at UNMH.

4) The problem remaining is that masks and distancing in an enclosed space do not fully protect from *aerosolized* virus - virus freed from the droplets and able to remain suspended in the air. These can be the result of very small droplets from which the water evaporates before falling, or from sonication in the pharynx for instance by rapid movement of the vocal cords. The WHO has generally downplayed the role of aerosol in transmission but counter-arguments have recently led do an acknowledgment that this mode of potentially prolonged airborne spread occurs though to what extent is still not clear. (https://academic.oup.com/cid/article/doi/10.1093/cid/ciaa939/5867798) Virus in this form is too small to be screened out by ordinary masks. To the extent that the volume of air into which such particles are expelled is large and mobile, then they can diffuse and thereby diminish in 'inhaled dose'. On the other hand the things that most effectively sonicate virus and render it aerosol are prolonged tones, especially at high volume, and probably enhanced

by percussive consonants, rolled 'r's and other attributes of good articulation. We find no work addressing the impact of a basic surgical or home-made mask in reducing the expulsion or inhalation of *aerosol* per se (as opposed to droplets) but we know a home-made or surgical mask can NOT contain all expired aerosol. More stringent masks like the "N-95" properly worn can provide protection against aerosolized virus but are not readily obtained and require individual fitting and scrupulous employment. (https://www.google.com/search?client=firefox-b-1-d&q=the+astounding+physics+of+N95+masks) However, as per the case of the salon workers cited above, ordinary surgical/homemade masks appear to be SO effective when worn universally that it seems unlikely that aerosol is a substantial day to day risk in most settings (though not choirs!).

So CAN a choir sing safely with distancing ?

None of the parameters noted in the May analysis have changed in actionable fashion so if the answer then was "No." then it remains the same.

How about in an outdoor venue?
Clearly there is simply no direct evidence to guide singers. Outdoor venues generally reduce risks considerably compared to enclosed spaces. Distancing may be more liberal outdoors too - for singers projecting the occasional fortissimo 6 feet may literally not be far enough. Certainly masks - if one can sing through them - should significantly protect from droplets. But the last piece of the puzzle is analysis of singing-induced aerosol - is being distanced masked and outdoors ENOUGH to prevent airborne viral inhalation in quantities sufficient to infect?

If you staggered performers in masks and made sure they weren't closer together than a somewhat arbitrary 4 meters and sang outdoors preferably with a little wind, it seems one would minimize risk. But we think there would need to be very singing-specific research on aerosolization in particular before this could be endorsed. Work in this area IS underway: https://smtd.colostate.edu/reducing-bioaerosol-emissions-and-exposures-in-the-performing-arts/ At present the best one could say is that risks are likely low, but how low is unclear and, more practically, whether they could be rendered lower also unclear.

Unless you can say the risks could be no lower, it is difficult to advocate for singing in this way.

VACCINES
Finally, a word on vaccines.

Conceptually, vaccination takes advantage of "humoral immunity" - that is, the arm of the Immune response that is mediated by 'humors', substances that can travel through the body in response to infection. Antibodies are the mainstay of this element of immunity, in

contrast to the complex 'cell-mediated' immune response not further discussed. The humoral immune system responds to a virus, for instance, by sorting out antibodies that precisely fit and bind to the structure of the antigen, in this case some portion of the virus. Those antibodies 'mark' the virus for additional immune system response but in the case of vaccines, the antibody response sought is one that will itself 'Neutralize" the viral threat.

Though not then understood in this mechanistic detail, the concept is not new. Jenner used exposure to Cowpox, a disease in humans similar but much less severe than smallpox, as a means of immunization in the 18th century. Careful inoculation of humans with tiny amounts of smallpox-infected material in hopes of prompting this immune response without inducing severe disease was an 'art' even decades earlier. The Sabin polio vaccine induced antibodies by exposure to an attenuated polio virus and the Salk vaccine used a killed virus. But one way or another the induction of immunity takes place by providing the immune system in a 'harmless' form, SOMETHING it will recognize and remember and respond to with lethal antibodies should the **real** infection occur .

It is important to note that not all antibodies are 'neutralizing'. The detection of antibodies to a protein in the Core of Hepatitis B may alert us to its presence, but are not themselves protective. Some parts of the structure of a virus may not be 'specific' enough to prompt a unique antibody response. But with other Corona viruses evidence has suggested that a particular 'spike protein' on its surface is essential to engaging and entering human cells. So, many vaccine programs have been trying to elicit antibodies to that protein. It is worth noting that to prove 'neutralization' means proving loss of viral replication. Viruses aren't 'alive' - they replicate by gaining access to a human cell and hijacking the machinery to make multiple copies of the virus, killing the cell in the process. Therefore measuring neutralization requires some form of living virus-infected cell system by which to judge success. Antibodies themselves are readily measured; whether they are truly neutralizing takes additional steps to establish.

Needless to say the means of deriving a single neutralizing antibody for a part of the virus that is stable and not subject to mutation and then demonstrating its safety and efficacy in an ethical fashion is daunting and has typically taken years. (Regular Influenza mutation is the basic reason that annual vaccines are required.) But the news this week regarding an accelerated methodology is exciting even as it deserves some healthy skepticism. (And there are more than a hundred serious well-funded vaccine programs working by various means on this problem, so to discuss the First is useful but hardly tells the tale…)

The report this week is of an RNA-based vaccine-development platform. (see for general background https://www.nejm.org/doi/full/10.1056/NEJMcibr2009737?query=featured_home) This means that investigators use the precise sequence of the Master Plan RNA of the virus (Human master plans are DNA but SARS-CoV-2 is among those viri

that use RNA) that determines a portion of the Spike Protein structure. Then - amazingly - this RNA "blueprint" for that protein is injected as a vaccine, gets into our human cells which 'read' it and manufacture that protein as instructed by that RNA. Now WE are hijacking our OWN cells to acquire immunity! The protein harmlessly exits the cells - (but without the rest of the virus of course so there is no 'infection' with a replicating virus) - where the immune system recognizes its 'foreign' structure and makes what is hoped will be neutralizing antibodies to it. And - voila! - the next time SARS-CoV-2 comes along, the antibodies to that spike protein are ready and waiting and the virus can't gain access to the human cells to replicate.

The preliminary report (https://www.nejm.org/doi/full/10.1056/NEJMoa2022483?query=TOC) that got attention was a "Phase I" trial - meaning a small number of humans receive the vaccine, homing in on dosing and establishing safety. Needless to say the end result is the production of antibodies that are assessed and found to be neutralizing NOT the exposure of these patients to SARS-CoV-2! The production of such antibodies in relevant concentrations WAS documented and an optimal effective dose was suggested in this interim report with no major safety issues. But we still need to see if this result actually conveys immunity as it should….

Traditionally Phase II trials follow with larger of #s of patients, all treated with the optimal dosing, and repeat confirmation of the desired effect is done before the Phase III trials are initiated. Phase III will finally have the robust numbers of patients to establish the efficacy of clinical effect and the safety of the product. THESE patients, once vaccinated, will be the group compared to placebo injection to be sure that the impact of the virus actually is the substantial reduction in the risk of the disease. Typically getting all the way to Phase III takes on the order of 5 years but this RNA platform speeds things along so that even before Phase I has been followed out for the final duration planned, Phase II has started and Phase III is being recruited. There is an ethics committee and firm 'stopping rules' in the protocols so that adverse effects would trigger review and revision or even abandonment. But so far so good.
The entire vaccine 'multiverse' is further considered in an accompanying editorial:
https://www.nejm.org/doi/full/10.1056/NEJMe2025111?query=TOC

Where does that leave us?
Well first a note of caution - this virus CAN replicated in immune cells even though respiratory cells seem to be the primary portal of entry. So if an induced antibody did NOT itself neutralize the virus but DID mark it for immune destruction, the virus MIGHT gain access to immune cells - certain classes of white blood cells - and replicate there. This Antibody Dependent Enhancement is always a concern and must be clearly excluded. It is quite a rare problem but it a sobering reminder of the exacting work that is required for vaccine success. https://www.nature.com/articles/d41587-020-00016-w And at this

point there is nothing in the protocols of development to suggest that safety considerations aren't front and center.

Meanwhile before we celebrate the imminent deployment of this vaccine -or some other - recall that ALL vaccines will require that Phase III trial. Recruiting people to take the vaccine or a placebo and then releasing them into the world (which is already trying to limit exposure) and THEN following the two cohorts until such time as the vaccinated group demonstrates statistically robust reduction in infection compared to the placebo group is work that can not be speeded up. Honestly - and grimly - it would be best to do that study in Brazil or someplace where the exposure rate would be high and the discrimination of effect - if there is one - easy and quick to see. The lower the exposure rate, the longer it will take to see difference between vaccine and placebo. (If one group or the other is clearly and significantly less likely to become ill or die, then the trial will be concluded at that time.)

So even though several vaccine -makers at least are now recruiting for such a trial - which itself takes time and scrupulous documentation and which won't begin until Phase I and II reports are final and acceptable and reviewed by the FDA - it is unlikely that such a trial will have definitive results within a time frame shorter than 6-9 months and possibly longer.

Of course there could be breakthroughs and there could be major setbacks. No crystal ball. But in the best Case scenario we might have individual protection conferred by vaccine late in 2021.

Final note - vaccines are MOST effective when the population takes them in such numbers as to achieve 'herd immunity". For a virus like SARS-CoV-2 that behaves so that each individual infected in turn on average infects three others, it would take roughly 2/3 of Americans having immunity to prevent an occasional outbreak from re-igniting logarithmic spread. Not everyone will respond to the vaccine - that is always the case. But if there is widespread refusal to take the vaccine then its full promise will remain unfulfilled. If you are one of the unfortunate ones who does not respond or who has medical conditions that attenuate response, you depend upon hour neighbors to derive immunity so that the likelihood of virus in the community is low and you aren't threatened. It is to be hoped that with demonstration of safety and efficacy we won't hamstring our own heroic scientific achievement by our behavior…

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May 2020 **Summary:**

1) The assembly of people for the purposes of Choral Singing creates a high-risk environment for the dissemination of the respiratory virus SARS-CoV-2.

2) There are no certain means of proving virus-free status of an asymptomatic singer without either serologic assurance of immunity or a viral swab and PCR -based assay showing no virus on the day of choral singing. As of mid-May 2020, testing for virus isn't available in a suitable time frame and serologic tests are not yet reliable.

3) The fatality rate for patients with SARS-CoV-2 is not yet certain, but whatever the absolute figure, it rises significantly with age above 50 and a majority of deaths take place in patients of 70 years and above.

4) The Coro lux average age is about 50 with a range from mid 20s to early 80s.

On the basis of these observations this committee cannot endorse resumption of choral singing when, even with precautions of distancing and interval face mask use, serious health risks are entailed. We recommend that ensemble singing not resume until the conditions of testing allow confirmation of immunity by reliable antibody tests and, if not immune, reliable, readily available testing for carriage on the day(s) of assembly. We acknowledge that to say the Risks at this time outweigh the Benefits of ensemble singing is not to deny the Benefits. The Board might explore the possibility of an interim virtual choir using the Chamber singers and/or consider holding virtual choir practices in preparation for a possible concert when safety for singers and audience is more secure.

We would suggest that approximately once a month the status of testing, community incidence and immunity, and treatment be reviewed to ascertain if this course of action remains appropriate. When it is safe to resume, reconsideration of the location and separation of singers may be important.
A brief acknowledgment of the compounding complexity of audience health is included below.

Literature Review

Introduction:
Processes designed to assist businesses in the decisions surrounding resumption of activities do not capture the unique aspects of Choral Singing - e.g.https://www.centerforhealthsecurity.org/our-work/publications/operational-toolkit-for-businesses-considering-reopening-or-expanding-operations-in-covid-19 and therefore, after evaluation, have been set aside in favor of de novo analysis. The data reviewed here may cite the original work but at times cite a broader and more accessible source in which the original citation is imbedded .

Significant improvements in treatment, progress in vaccine development, emerging and significant complications of the disease (for instance the increasing recognition of a multi-organ inflammatory syndrome in children https://www.who.int/news-room/commentaries/detail/multisystem-inflammatory-syndrome-in-children-and-adolescents-with-covid-19) and other features of the disease are not relevant to this discussion but can be tracked through the CDC web site or the websites of such large clinical organizations as the Mayo Clinic or Johns Hopkins.

A couple of very useful articles providing background immediately pertinent to decisions on activity resumption : https://www.erinbromage.com/post/the-risks-know-them-avoid-them and https://medium.com/@tomaspueyo/coronavirus-act-today-or-people-will-die-f4d3d9cd99ca The latter was written when US cases were barely 1000 so absolute numbers are no longer accurate but principles and implications remain valuable. Reading these two papers probably supplies all the background information required for a deep understanding of the issues.

Review:

SARS CoV-2 needs no introduction. It is a highly infectious virus that gains intracellular access through the Angiotensin Converting Enzyme Receptor 2, mostly (but not exclusively) found in the lining of the respiratory system. Some useful tools appear to have been recently incorporated into supportive care for the most ill, but there is neither curative treatment nor vaccine prevention at this time. Estimates of illness-fatality rates or case-fatality rates are hampered by lack of accurate prevalence figures but the contagion has become among the most common cause of death in the United States (https://www.cdc.gov/nchs/nvss/vsrr/covid19/index.htm). In New Mexico as of 5/19 the ratio of deaths to test-postive patients is 4% (see NM DOH) but this approximates an illness-fatality ratio to the extent that testing so far still skews to symptomatic and high risk patients. A true case-fatality ratio will be lower once community prevalence (including milder or unrecognized disease) is established but these numbers need not be a distraction at this time - the importance and significance of the disease is apparent from NM ICUs at 100% occupancy with COVID-19 (the viral-induced illness) throughout the state as well as the ongoing daily deaths; high rates of contagion greatly amplify the impact of any and all rates of lethality. Final accurate numeric description of the virus will emerge gradually over the remainder of the year, but it appears there will be at least 100,000 US deaths verified by the first of June.

Airborne spread is the means of transmission most relevant to choral singing. Disease transmission efficiency rises with the size of the innoculum (which may also influence disease severity). At 0.1 micron in size, the virus can be spread in droplets released most avidly in sneezing and coughing but also in mere talking. Droplets tend to fall to the ground and conventional CDC recommendations have suggested that a 6 food perimeter minimizes risk of contagion but this is largely a theoretical construct. (see https://www.nytimes.com/2020/05/14/health/coronavirus-infections.html?smid=fb-share&fbclid=IwAR1qS9PkkTSSvHuENBw6xiYXvFC5V07TatctU1_X1sa0h39D1Q5d6mZCwRM) Viral particles can also be aerosolized and linger in the air long enough to be measured (without quantitation) for several hours. Even droplets can remain airborne or travel further through air moving with a heating/cooling system or the wake that follows someone walking by. Therefore efforts to reduce transmission risk must in theory address both droplets and aerosols. The thinking at present is that aerosols are not the primary means of viral spread or the R-nought for the virus from the beginning would have been higher.

Reduction of the risk of other airborne viruses has been the subject of serious study for many years (See https://www.washingtonpost.com/local/trafficandcommuting/scientists-think-they-

know-ways-to-combat-viruses-on-airplanes-theyre-too-late-for-this-pandemic/2020/04/20/83279318-76ab-11ea-87da-77a8136c1a6d_story.html and for a general discussion that includes a setting of choral singing see https://www.erinbromage.com/post/the-risks-know-them-avoid-them)

In general the barriers to infection within the host are such that some minimal number of viri are required together to represent a 'dose' likely to infect. This might be likened to scoring a goal in hockey - the more shots on goal you take the more likely you are to get one in the net. There is no clearly recognized correct "number" of viral particles guaranteed to cause infection (see https://www.statnews.com/2020/04/14/how-much-of-the-coronavirus-does-it-take-to-make-you-sick/) but it is clear that viral shedding in SARS-CoV-2, unlike SARS and MERS, is near maximal numbers at the time symptoms begin and infectious doses are present for days prior to symptoms. (See New England J Medicine 3/5/2020 382: 970 and also https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30196-1/fulltext)

The efficient spread of airborne virus as an aerosol takes place in the anterior mouth where sheering of mucus and outward projection take place. By some estimates - these are based on modeling assuming a pharyngeal concentration of SARS-CoV-2 virus of 10 to the 8th per tenth of a cc (as measured in the patient noted in the NEJM article above) - just speaking may release 320 infectious doses per hour. (https://www.medrxiv.org/content/10.1101/2020.04.12.20062828v1.full.pdf+html; see also https://www.pnas.org/content/early/2020/05/12/2006874117) These numbers rise with the volume of voice and probably also with the articulation of singing. Certainly the practical risk of infection arising from choral singing has been confirmed in a large choral singing-related outbreak. (https://www.latimes.com/world-nation/story/2020-03-29/coronavirus-choir-outbreak) . Thorough epidemiological evaluation concluded of this particular event:

Among 61 persons who attended a March 10 choir practice at which one person was known to be symptomatic, 53 cases were identified, including 33 confirmed and 20 probable cases (secondary attack rates of 53.3% among confirmed cases and 86.7% among all cases). Three of the 53 persons who became ill were hospitalized (5.7%), and two died (3.7%). (See Morbidity and Mortality Weekly Report 5/20/2020).

Choral singing is not common enough to appear on "proximity indices" for risk (https://www.stlouisfed.org/on-the-economy/2020/april/impact-social-distancing-ripples-economy) but clearly from the theoretical and empiric evidence above, it is a high risk setting for SARS-Co-V2 spread. Of note, high risk proximity in the State of NM is considered 3 minutes or more within 6 feet of an infected person, though if either the index case or the exposed party wear masks, that definition is extended to 10 minutes of contact. (NM DOH - personal communication).
The outcome for COVID-19 infection worsens notably with age (after about 50) and with underlying medical conditions esp heart disease and Diabetes. Mortality rates approache 30% above age 80. (see https://www.bloomberg.com/opinion/articles/2020-05-07/comparing-coronavirus-deaths-by-age-with-flu-driving-fatalities) Nevertheless it is not exclusively the elderly who succumb - the last 9 deaths in NM as of weekend of 5/9-10 included one each in the 7th,

8th and 9th decades; the other 6 were in people in the 4th 5th and 6th decades. Mechanical barriers to expectoration of the virus are probably useful but it only in rare cases that a singer's contribution to the choir improves with masking. The Coro lux age range is 41 to 83 with an average age of about 50.

Identification of patients who are recovered and possibly immune to further infection is problematic. (See https://www.centerforhealthsecurity.org/resources/COVID-19/serology/Serology-based-tests-for-COVID-19.html) While it is likely that most patients who recover from COVID 19 will have antibodies and most antibodies will be protective, the titer required for immunity and the duration of the effect are unknown. More serious, and discussed in detail in the reference, testing for protective antibodies still has such technical issues with both false negative and false positive results that particularly for a population with low prevalence, the false results may out-number the true. The promise of serology to define an 'immune' population remains, but is not yet reliable.

Testing for the presence of nasopharyngeal virus by lab-based PCR testing is highly accurate, and broadly available in New Mexico but requires from 2 days to two weeks for results depending upon the lab. (Personal communication NM DOH; Qwest is responsible for all the long waits.) Rapid Tests appear still to have problems with sensitivty. (https://www.npr.org/sections/coronavirus-live-updates/2020/05/14/856531970/fda-cautions-about-accuracy-of-widely-used-abbott-coronavirus-test)
The incubation period of the virus averages 4-5 days but can be longer. The prevalence of asymptomatic or pre symptomatic carriers is unknown. Thus at this time it does appear possible to be assured by lack of signs and symptoms of disease that any given member of a choral group (or audience) is *not* contagious.

On the basis of these and other data it appears that the presence of asymptomatic or pre- symptomatic disease allows unwitting spread of SARS-CoV-2 and that the articulation and volume of singing are among the most efficient means of disease spread. Spacing, barriers such as masks and air-recirculation devices can probably lower the risk but cannot render choral singing absolutely safe.

In medicine, the decision to intervene is most often made balancing the benefits and risks. Purely cosmetic surgery with a 60% mortality rate is unlikely to take place, whereas surgery also carrying a 60% mortality rate might be done enthusiastically when the alternative was certain death. This committee is not in a position to establish the Benefits of Choral singing, significant though they might be, in a currency that can be freely exchanged with the risks to life itself. Under the circumstances we would recommend a hiatus in Coro Lux group activities until such time as maximal safety can be established, presumably when it is possible to quickly and accurately confirm immunity and absence of contagion risk. Regular review of community health status and testing technology should, in our opinion, be set in motion to establish when these conditions are met or superseded by other considerations. The potential for singers combining voices from individual recordings to create ensemble sound is of course without COVID-19 risk.

Audience considerations:

Choral practice is usually intended to culminate in a choral performance. Arguably the willingness to program and support such a concert implies to the audience a venue safe from viral disease. Should new infections be ascribed to assembly at a concert, the practical implications will be the same whether virus originated from the stage or from the seats. Thus, again arguably, the responsibility of a choral society extends beyond their membership to an audience whose viral and immune status are unknown. Social distancing, masks, and perhaps some attention to H-VAC can be used to reduce audience risk, but ultimately this element of the interruption of viral spread is beyond institutional control. To the extent that a live concert contains a tacit approval of the gathering, there may be an additional duty on the organizers to proceed only when protection has been maximized and limitations of safety are shared transparently with all potential audience members. Presumably many older fans of choral music or those at risk of more severe disease for other reasons will be reluctant to attend until there is some empiric experience on which to draw.

Joseph Alcorn MD, Committee Chair
Karen Ellingboe RN, MSN
Chester Sakura MD
Quynh Truong RN