



Research Article

# Bioaerosol Spread of COVID-19 and TB in Air Conditioned Spaces: How the Court Spearheaded the Movement in India

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DOI: <https://doi.org/10.24321/0019.5138.202205>

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### How to cite this article:

Singh R, Dewan A. Bioaerosol Spread of COVID-19 and TB in Air Conditioned Spaces: How the Court Spearheaded the Movement in India. Special Issue - COVID-19 & Other Communicable Disease. 2022;30-35.

Date of Submission: 2021-12-17

Date of Acceptance: 2022-01-17

## A B S T R A C T

The measures taken in buildings to make them resilient against the spread of airborne diseases have seen a rise during the COVID-19 pandemic. Changes in the heating, ventilation and air conditioning systems are of importance as bioaerosols spread through recirculation based air conditioning systems. This can be tackled by sanitisation or by dilution ventilation caused by increased fresh air supply. In response to a written petition by a lawyer on the issue of air conditioning in the court premises and the spread of COVID-19, the Delhi High Court held the Fundamental Rights of the citizens by extending it to a right to a healthy environment and acknowledging the concerns in the petition. A committee was also set up by the court to relook at the ventilation and air conditioning within the court. The Right to Information Act, 2005 was used to obtain the minutes of the committee meetings. This short communication discusses the decisions which provide insights into the lack of reliable information available in the initial phases of the meetings. This has been hinted to show the possible lack of regulation for infection control through airborne route in public buildings. Design decisions are also looked at. This paper aims at providing a commentary with the aim of linking research and practice in the area of bioaerosol spread of diseases like COVID-19 and tuberculosis in public spaces.

**Keywords:** Bioaerosol, Airborne Infection Spread, Air Conditioning, Buildings and Disease Spread, COVID-19, Tuberculosis

## Background

In New Delhi, India there were two peaks of COVID-19, one in November 2020 and the other major devastating one in April 2021. From the time Delhi saw its first lockdown in March 2020, there were concerns about the spread of the disease in public spaces, especially the ones which are enclosed and are under Heating Ventilation and Air Conditioning systems. It is worth noting that the concern

of the airborne spread of COVID-19 in Delhi was prevalent long before the WHO declared that COVID-19 spreads through the airborne route along with the existing contact, droplet and fomite routes.<sup>1</sup>

## The Public Interest Litigation for Dilution Ventilation

A Civil Miscellaneous application was filed in the Delhi High Court in May 2020.<sup>2</sup> This was tagged along with an

*Journal of Communicable Diseases (P-ISSN: 0019-5138 & E-ISSN: 2581-351X)*

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existing case of Air Pollution in Delhi<sup>3</sup> which was being heard in the Court since 2015. The court urgently and immediately heard the application and this started the chain of events in India with the Delhi High Court taking lead. The application stated that 'it will be foolhardy to assume that all the infection coming out or thrown up by an infected person, would be in droplet form only'. Though the scientific device evidence at that time suggested that COVID-19 'is communicated through contact with droplet infection from an infected subject to a non-infected one', the application took a leap by suggesting for the prevention of airborne spread of infection even when it was believed that the aforesaid droplets do not largely disperse in the air (they settle on various surfaces wherefrom if touched by a non-infected person, they can be transmitted to that person through contact with eyes, nose or mouth). This assumption, without any sure scientific evidence at the time, on the basis of preliminary studies, paved the way for stringent action in India which was helpful even when WHO actually declared transmission of COVID-19 through the airborne route about three months later.

### Release of Guidelines for the Use of Air Conditioners

The filing of this application coincided with the release of guidelines for the operation of air conditioners by India's Central Public Works Department<sup>4</sup> and the Indian Society of Heating Refrigeration and Air Conditioning Engineers (Indian Society of Heating, refrigeration and Air Conditioning Engineers, 2020) within a span of one month before and after the petition. Both the documents advised the use of Dilution Ventilation by increasing fresh air supply into the

indoor space either by directly opening windows or through the internal mechanism of the installed Air Conditioning System. Dilution Ventilation can be provided by increasing the filtered fresh air supply into the AHU's of Central Air Conditioning Systems, installing TFA systems in VRV and larger split/ cassette type systems. In the case of personal air conditioners in individual rooms, the windows should be kept open as much as possible for the required Dilution Ventilation

### The Action of the Graded Committee to deal with Airborne Infection Control

The Delhi High Court, as a result of the writ petition as stated above, ordered the setting up of a Graded Action Plan Committee for the premises of the Delhi High Court. The Delhi High Court is a major court just below the Supreme Court of India at the jurisdiction level. It is located in a busy part of New Delhi. The complex has three main blocks, A, B and C. The A block is the main Block, B is the Extension Block and C is the New Block. The older blocks A and B were retrofitted as air-conditioned buildings, whereas the new C block was built as a fully air-conditioned building with central AC without any hybrid method for ventilation. The committee was set up to evaluate the use of air conditioners during the COVID-19 pandemic in the Delhi High Court. This committee met 5 times between April 2020 and June 2020 and resulted in measures for the court premises. The minutes of the committee were requested by the author as an application under the Right to Information Act, 2005. The reply was derived in a tabulated format. The reply was abridged and a commentary has been discussed in Table 1 below.

**Table 1. Recommendations and Actions only with respect to the Air conditioning and Space Ventilation**

Date of	Source of Inputs	Discussions/ Measures	Author's Remarks on the Discussions/ Measures
23rd April 2020	<ol style="list-style-type: none"> <li>1. An engineer from the Electrical Department of the Public Works Department.</li> <li>2. A doctor from the medical team of the court.</li> <li>3. A senior official from the Court.</li> </ol>	<ol style="list-style-type: none"> <li>1. The new block has a heat recovery wheel which does not ensure the supply of fully fresh air, hence air conditioning cannot happen in this block.</li> <li>2. The older blocks (main block and extension block) have provision for ventilation and exhaust hence can be made operational with additional measures.</li> <li>3. Air sanitisation technologies like UVGI (duct type for the Central AC) and Ozonation Device using gas chamber were introduced in the meeting.</li> </ol>	<ol style="list-style-type: none"> <li>1. Heat recovery wheel, a mechanism that reuses the cooled air, is installed to increase energy efficiency, but the cost is the recirculation of stale air. This is not suggested when preventing airborne infection spread.</li> <li>2. The newer ACs have a heat recovery wheel, and there is lower ACH possible for reducing energy consumption. This is at the possible cost of infection control<sup>5</sup> any recirculation leads to non dilution of aerosolised pathogens which leads to increased probability of infection spread.</li> </ol>

<p>28th April 2020</p>	<ol style="list-style-type: none"> <li>1. An engineer from the Electrical Department of the Public Works Department.</li> <li>2. A senior engineer from the Public Works Department.</li> </ol>	<p>A report was submitted as suggested on 23.04.2020.</p> <ol style="list-style-type: none"> <li>1. UVGI was suggested to be not used as they 'can only disinfect the air received in AHU for re-circulation and if any COVID-19 infected person enters the area having Central Air Conditioning, there is still every likelihood that particles of such virus, exhaled by such person, may remain airborne and may, in turn, infect others.' The committee also considered that even in the apex court of the country, the Air. Conditioning was switched off, and instead of investing a huge amount on procuring UVGI devices, it would be better that wall/ pedestal fans be instead used for ventilation.</li> <li>2. All fans will be proposed to be reinstalled, wherever possible.</li> <li>3. Wire mesh may be put in windows in order to open them and prevent the entry of mosquitoes/ insects and enable 'proper ventilation during the working hours'.</li> </ol>	<ol style="list-style-type: none"> <li>1. The decision of not using UVGI as it may 'only disinfect the air received in AHU' and not the one 'exhaled by an infected person' lacks the understanding that air in the rooms is being constantly pumped and cycled through the HVAC systems and this is one channel where it can be disinfecting in the way.<sup>6</sup> In a guinea-pig study from Peru, use of UVGI displayed a substantial reduction in TB infection.<sup>7</sup></li> <li>2. Wire mesh is not a standard installation in office buildings in India and is fast going away from residential buildings too due to the use of HVAC.</li> </ol>
<p>6th May 2020</p>	<ol style="list-style-type: none"> <li>1. A senior scientist from genomics and integrated biology research institute.</li> <li>2. The Head of Department of Pulmonary department of India's apex tertiary care hospital.</li> <li>3. An electrical engineer from the public works department.</li> </ol>	<ol style="list-style-type: none"> <li>1. For Centralised Air Conditioner plants, the important point are:                     <ul style="list-style-type: none"> <li>• Proper ventilation</li> <li>• Proper filtration</li> <li>• Creation of negative pressure zone</li> </ul> </li> <li>2. It was resolved that with 'proper air-exchange rate and in case the exhausted air is not entirely recirculated, the centralised AC plant can be operated with adequate filtration systems, though at the cost of some rise in temperature in the building'</li> <li>3. The senior doctor and senior scientist will study the UVGI brochure and details.</li> <li>4. In old blocks, namely A: Main Building and B: Extension Block, there were provisions for adequate ventilation in most rooms. Whereas in the new block building, there was 'no provision of ventilation/ fresh air. It was contemplated that 'some provisions can be made for ventilation/ fresh air in the New Block by cutting/ removing the glass at designated places'.</li> </ol>	<ol style="list-style-type: none"> <li>1. Proper ventilation and filtration are important but need quantification in terms of the ACH or CFM/ person and the filter sizes in the case of filters.</li> <li>2. In point 4, it is surprising to see that newer buildings in their design have no provisions for any hybrid ventilation by openable windows. Buildings with glass curtain walls and fixed panes should be avoided, especially in a building of public function.</li> <li>3. The design of public washrooms without provisions for exhaust requires deliberation by designers at the stage of initial planning.</li> <li>4. Location of AHUs and construction after the building is commissioned makes it incoherent with the initial planning. The cost this time was the lack of ventilation to certain important spaces without a public building.</li> </ol>

	<p>4. A senior engineer from the public works department.</p>	<p>There was no provision, according to the Electrical Engineer, 'of exhaust/ventilation in the public washrooms situated in New Block Building'.</p> <p>5. Due to the additional construction done later, 4 courtrooms in Block B have no provision of ventilation and The AHU to service certain courtrooms and chambers are 'not in the corner', some 'extra time' will be required 'to make these ready'.</p> <p>6. The following recommendations with respect to the air conditioning were finally made:</p> <ul style="list-style-type: none"> <li>• Start courtrooms in older blocks where provisions in AHU were possible.</li> <li>• A report to be resubmitted by the Public Works department engineers, to know as to 'what steps are required to be taken for the purposes of getting proper exhaust/ventilation for the older blocks A and B.</li> <li>• The public works department was further ordered to:             <ol style="list-style-type: none"> <li>1. Specify additional fans, for areas where Central AC will be switched off.</li> <li>2. Similar steps are communicated to subordinate courts outside of the High Court.</li> <li>3. Install wire mesh/ net on all windows.</li> <li>4. Filters in the AC plant be checked and changed regularly.</li> </ol> </li> </ul>	<p>5. The subordinate courtrooms require urgent action as this closure due to lack of proper ventilation makes the courtrooms unusable, especially when the ventilation is required for airborne infection control. This delays justice and causes misery in society.</p>
<p>14th May 2020</p>	<p>1. Executive Engineer, Public Works Department. 2. Senior Engineer, PWD. 3. Junior Engineer from the Electrical Department of PWD.</p>	<p>1. Certain AHU for supplying to rooms, including the Chief Justice's chamber due to its location may not be supplied with proper ventilation and the rooms cannot be used.</p> <p>2. Split air conditioners may be used in these rooms where the AHU may not be supplied with fresh air.</p> <p>3. Wire Mesh for the windows, as suggested on 06.05.2020, if used on windows, 'May increase the risk of infection by reducing the air flow' was suggested by the Electrical Engineer of Public Works Department.</p> <p>4. A senior judge will visit the court along with a doctor, a scientist-researcher, the in house doctor and a senior architect who was involved with the new building.</p>	<p>1. Usage of a split air conditioner may be done, but appropriate action, in terms of manually opening the windows must be done. This is often missed by the users. This is of more consequence where there is a scope of public interaction and a higher risk of infection spread.</p> <p>2. The suggestion that use of wire mesh may increase the risk of infection due to reduction of airflow is problematic. There may be a reduction in airflow, but it is one step better than hermetically sealed spaces and will play a role in reducing infection spread. Office buildings should be mandated to have wire meshes in the initial design stages.</p>

<p>4th June 2020</p>	<ol style="list-style-type: none"> <li>1. A senior High Court Judge.</li> <li>2. The Director of research institute of genomics and integrated biology, a scientist himself.</li> <li>3. The in-house senior doctor.</li> <li>4. A senior architect, who was also involved with the new building.</li> </ol>	<ol style="list-style-type: none"> <li>1. The Central Air Conditioning plants of all the three buildings can be 'made operational after carrying out certain modifications'. The ones directly related to air conditioning and ventilation are as follows:                     <ol style="list-style-type: none"> <li>1. Doors and windows to be opened as much as possible.</li> <li>2. High volume, low-velocity fans to be installed in common areas.</li> <li>3. High volume, low-velocity fans to be installed in courts wherever possible, else largest possible fans be installed.</li> <li>4. In all other rooms, fans are to be installed. (Note: Due to HVAC, fans were removed earlier in older buildings)</li> <li>5. All toilet windows to be kept open.</li> <li>6. All return air ducts to be sealed at both grill level and inside the closing of all return air grilles and diffusers in the AHUs.</li> <li>7. An 'attempt to be made' to create a path of air to be taken out of the building.</li> <li>8. Fresh air to be made available for all the AHUs.</li> <li>9. Arrangements to be made to provide fresh air through a duct along with a fresh air fan for a large courtroom of the Chief Justice. The duct will have a motorised damper and gravity louvre. The damper and the fan 'to be interlocked with the AHU'</li> <li>10. Toilets and pantry exhaust fans will always remain on.</li> <li>11. 'Fresh air/ exhaust arrangement for smoke extraction' in the new block (Block C) is to be made to operate on a timer (switched on for 5-10 minutes after every 45-60 minutes). The grills on the openings are to be replaced by Louvres for noise reduction.</li> <li>12. The exhaust side of the heat recovery units be switched off.</li> <li>13. All the filters, grilles, diffusers, internal surfaces and coils be sanitised.</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. These recommendations in the correct spirit must serve as a lesson for future designers of public buildings. The spread of airborne infection is not new.<sup>7,8</sup> Tuberculosis, not eradicated in India and a cause of deaths in India, is another airborne infection that automatically is reduced if steps for COVID -19 are implemented, at least from the environmental control point of view.</li> <li>2. The recommendation with respect to airflow lacked any quantitative measure with respect to Fresh air changes per hour or the CFM/ person.<sup>9</sup> A simple suggestion of fresh air supply may lead to the under design of ACs.</li> </ol>
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**Conclusion**

This case study highlights the following key points:

1. Use of the Right to Information Act, 2005<sup>10</sup> as an important tool in the hands of researcher in India<sup>11</sup> and other countries where analogous Acts exist, for example, the Freedom of Information Act in the United States.

This enables access to otherwise inaccessible data for researchers without any complicated permissions and requests for the same. This is a tool in the hands of researchers to also take up issues which is crucial to society and may be difficult for the government to share due to certain conflicts of interests.

2. There is an immense scope in India to regulate the use of Heating, ventilation and air conditioning in the building sector, as it is crucial to public health. These regulations or codes can be specified in the Unified Building Byelaws which will make their implementation mandatory, instead of them being part of guidelines that are suggestive in nature.<sup>4</sup>
3. The need for having an integrated approach at the initial design stage so that unforeseen problems can be accommodated. This is also mandated in Part 0 of the National Building Code, called the integrated design approach.<sup>12</sup> Designs that give importance to one parameter, at the cost of another may be of consequence. This needs to be resolved by practitioners at an early design stage.
4. It is also important to classify biological contaminants as pollutants as the National Building Code<sup>13</sup> has made Air Changes per Hour standards by notwithstanding the presence of contaminants<sup>14</sup>. Inclusion of these, or an acknowledgement of dilution ventilation for airborne infection spread will give recognition of the public health angle of ventilation. There is also urgent need to include Indoor Air Quality under the purview of the Air (Prevention and Control of Pollution) Act, 1981<sup>15</sup> as currently only ambient air is given the attention.

### Declaration

No funding was taken for this study. All authors contributed equally to this study and declare no conflict of interest.

### Acknowledgements

The authors would like to thank Adv KC Mittal, Former Chairman, Bar Council of Delhi for his support. Special thanks also to Dr Satish Kaipilyawar for his support.

**Conflict of Interest:** None

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