5th May 2020

An Engineering Overview on controlling Airborne diseases

(Measures to be taken by facility administrators)

Commercial establishments might kick off their operations after receiving the government order to resume functioning. Govt. of India has taken a timely step to reduce the spread of the disease and has imposed the lock down. The most important part of the lock down is that it has helped every individual to safely learn about the behaviour of COVID-19 and induce a change within, which shall continue helping to limit the spread of this fatal disease. Anyhow there are no pharmaceutical remedies for COVID -19 in place. Hence each and every individual who is getting out from their home for work has to ensure that they are practicing adequate steps to prevent from being infected of this fatal disease.

DO's and DON'Ts to curb the spread of COVID-19 is a common topic of discussion everywhere. For an official assuming a larger responsibility of managing facilities of a corporate office shall have to know the subject a bit more in detail. The below discussion may help facility administrators to summarise their knowledge base about COVID -19 and such Airborne Diseases and their prevention in the facilities they administer.

As per Centres for Disease Control (CDC), in case of an outbreak of a new type of virus, for which vaccines are not available, Non-Pharmaceutical Interventions (NPIs) are recommended. NPIs are methods to curb the spread of an epidemy without medicines and vaccines by controlling the chain of Infection.

Concept of the Chain of Infection

The chain of Infection is as below:

1. Adequate number of pathogenic organisms (dose)
2. Pathogenic organisms of sufficient virulence
3. A susceptible host
4. An appropriate mode of transmission or transferal of the organism in sufficient number from source to host
5. The correct portal of entry into the host

A transmission becomes impossible if any of the link is missing in the above. If one understands this chain, it becomes easy to break the chain and escape from the infection.

Let's understand and eliminate them to contain the spread of COVID-19 even while we work after the withdrawal of the imposed lockdown. These measures discussed below can be categorised as either source control or environment control.

Below discussion is an attempt to understand these five terms forming the links of the chain of infection and ways to eliminate them.

1. Adequate number of pathogenic organisms

The microbes (pathogens) enter the air stream through Sneezing, coughing, talking, breathing and through spitting by an infected person. Microbes may be present in faeces of an infected person. Hence it can enter air through splashes produced during flushing the toilet.

Droplets of size above 10 microns settles down in fraction of seconds to a few minutes on floors, table surfaces, clothes walls etc. droplet nuclei of size less than 5 microns have higher float time and stays in the air for longer time and may be respirable.

Use of a face mask gives both outward and inward protection, at different degrees depending on the type of the mask. If everyone uses face mask, preferably N95 (if not possible surgical mask may also be used), the pathogens entering the air will reduce. This is how we can control the source.

The microbes may enter these surfaces through direct contact as well. Either way, microbes are to be disinfected from the surfaces.

Frequently cleaning the floors, tables, High touch surfaces such as door handles, lift buttons etc. will reduce transmission through this mode. Use phenolic solutions or Sodium hypochlorite solution for floors, tables etc. Use 70% iso propanol or ethanol for disinfecting other surfaces where the phenolic solutions can't be used.

Entry of microbes to the air stream is discussed above. The microbes won't sustain in the air stream as individual particulate. The size of most virus is in the range of 0.1 to 0.3 microns. Size of Corona Virus is 0.08 to 0.2 microns. (80 – 200 nm). These pathogens often stick to floating dust particles of size about 3- 5 microns and becomes aerosols and become respirable to the occupants.

Controlling the dust level in the occupancy zone is important to reduce the number of floating infected particles. Using sufficient level of air filtration shall help to reduce the dust level. Room air conditioners often is not equipped with filtration of this level and the fan power is not sufficient either. Air Handling Units are often equipped with higher grade of air filters. An additional in the room air filtration unit can be installed to compensate the deficiency of the air filters.

About 5 ACH and 3-micron filtration shall be used.

Sufficient ventilation is to be provided so that the concentration of the microbes reduces by dilution with clean outdoor air. Care should be taken that the intake air is from a clean area and without any pollutant or microbes in them. Always the exhaust air stream and fresh air intake stream should have sufficient separation.

As the existing HVAC system would not have been designed to match the requirements of an epidemy of the prevailing nature, it may be exercised that in every 2-3 hours of working, windows and doors be opened and the HVAC system be kept running (in fan mode) for about 15-20 minutes so that the room air be replaced with the outdoor air in between to reduce the concentration of the microbes.

2. Pathogenic Organism of Sufficient Virulence.

The virulence of a microbe is a property of the microbe itself. Anyhow the infectivity is having relationship to certain environmental factors. At humidity level above 70% the infectivity of virus tends to reduce. Such data might not be available in respect to SARS CoV-2 but may be apprehended from such studies on influenza virus.

Maintain the room temperature at about 26 or 27 deg C or whichever highest temperature that suits the occupants in general.

A lower humidity also adversely affects the human body's natural defensive mechanism towards microbes and foreign bodies that effectively trap while it's transport from nasal entry to the lungs through the respiratory tract. This will be discussed later.

Disinfecting the virus with UV lamps placed in closed air loop (in duct work of AHU) shall help reducing the number of active microbes in the air stream. A study suggests 14 mJ/cm2 of UV energy reduces the concentration of Corona Virus to 0.01% by numbers.

3. A susceptible host

A healthy individual is less susceptible for an infection. There are various takes and discussions about immunity of an individual and is by itself a vast topic of discussion. Not going in to details, a summary of points that is relevant to the scope of this discussion is given below.

Human Respiratory tract is equipped with various mechanisms to capture the entering pathogens and other foreign bodies. By keeping a lower humidity, the mucus layer gets dried out and the trapping mechanism becomes less efficient. After reaching the lungs, neutralising the virus becomes much difficult for the body.

Some healthy practices to keep the body immune may be

- Follow immunity boosting food habits
- Sleep for at least 7- 8 hours a day
- Keep body hydrated with clean water
- Breathe slowly and through nose only especially in a potentially exposed environment
- practice breathing exercises to increase vital capacity

The idea is to make the human body to fight against any microbe before it really crosses the alveoli to enter a cell. There are still human immunity mechanisms to kill the microbes within the body and the efficiency of prevention and recovery depends on the formation of antibodies etc., details of which are not the scope of this discussion.

4. An appropriate mode of transmission or transferal of the organism in sufficient number from source to host.

We have explored the modes through which pathogens enter the environment. These microbes must take another host through various routes for a transmission to happen. There are no available data for SARS CoV-2 that says the minimum numbers to be entered to the host to cause an infection. Even a single virus of sufficient virulence may be considered sufficient for causing an infection.

What we need to look at is the modes of transmission.

- Floating aerosols containing infective virus may be inhaled by the occupants
- If sufficient distance is not adopted between people, the droplets may directly be inhaled by an individual. Social distancing finds its relevance here. Also larger droplets may rest on clothes and body parts which shall work as a reservoir for these pathogens and cause a potential entry at a later time.
- A healthy individual may touch any of the surfaces / objects carrying the infected droplets.

Aerosols are often smaller particles and obviously shall contain lower concentration of microbes than having a direct contact.

Frequently washing hands with soap (as per the prescribed procedure) will reduce the risk of carrying the virus on hands there by getting entry to the body while touching the face.

5. The correct portal of entry into the host

Unless an infectious virus enters the host through mouth, nose, eyes etc, it can't cause infection to the new host. Wearing a face mask gives inward protection as well. N95 masks can filter 95% of particulates with sizes above 0.3 microns and if worn properly can protect the individual to a very high degree from infections. Even disposable surgical masks shall help to some extent. The masks shall be changed every 6 hours and shall be discarded safely.

The above discussion is an elaboration of the concept of social distancing.

Summary of Recommendations for Maintaining Offices post lock down.

HVAC Systems

- Ensure all existing air filters are properly installed
- Clean the air filters frequently. Care must be exercised that while cleaning the filters the microbes don't enter the air stream and the service personnel.
- Consider adding an in the room air filter of 3 micron with 5 ACH
- Check the existing ventilation provision functioning and consider increasing if required
- After every 2- 3 hours, run the HVAC system (in fan mode) for 15- 20 minutes with doors and windows open, letting good amount of outside air to replace the indoor air.
- Keep higher humidity levels subjected to keeping minimum level of thermal comfort (RH >60% is possible)
- Consider installing UV lamps in concealed duct systems to disinfect virus
- Ensure fresh air intake is from a non-polluted area and the exhaust air is separated sufficiently from intake air

Cleaning / Hygiene

- Disinfect High Touch surfaces such as lift button, door handle etc., with 1% sodium hypochlorite (NaOCl) solution/ Cresol / 70% Isopropanol or ethanol frequently
- Provide hand sanitising stations. If possible, provide a hand wash area with soap and water with no doors or access button requirements.
- Clean floors, table tops etc. with 1% Sodium hypochlorite solution once or twice a day
- Provide safe means of disposing gloves

General

- Enforce use of face mask in the premises
- If anyone is found sneezing in indoors, get the area cleaned with Sodium hypochlorite Solution and ventilate the room for 15- 20 minutes
- Check body temperature through IR thermometers before entering
- Keep sufficient distance between people. Avoid crowding. Make tea / lunch time in shifts to avoid crowding
- Minimise document and object transfers to the extent possible. Check options for disinfection of objects if to be transferred.
- Consider keeping frequently used entrances with doors open in order to avoid frequent touching of access buttons, handles etc. depending on the situation.
- Keep toilet exhaust fans running.
- Avoid flushing WC with open lids
- Do not spray sanitisers in such a way that it cause splashing of the settled particles.

This document is prepared to give certain insights to the facility administrators for commercial establishments and corporate offices. Though, the author has taken due care to validate the accuracy of the information presented here from

science journals and other sources, if any of the information provided contradicts any notifications/ guidelines provided by the government, the reader is advised to follow the information provided by the government sources.

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- Ventilation Projects
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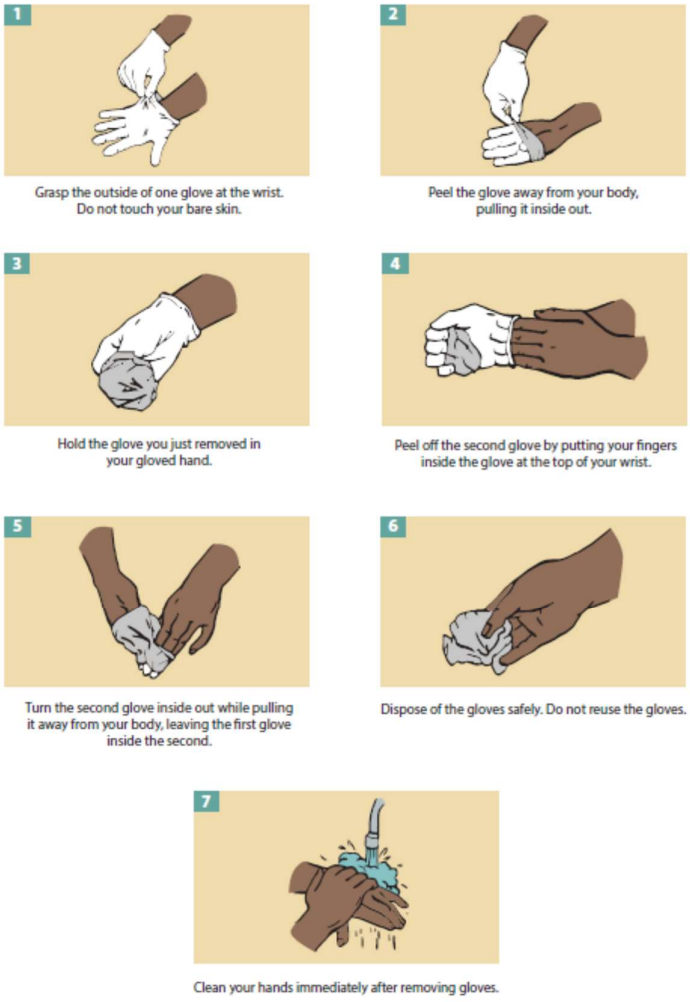
Source : https://www.mohfw.gov.in/pdf/Guidelinesondisinfectionofcommonpublicplacesincludingoffices.pdf

How to Remove Gloves

To protect yourself, use the following steps to take off gloves



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