Displaying Adequate Ventilation Provision in Crowded Gathering Places

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Abstract

Upon relaxing COVID-19 control, ventilation provision is no more controlled at 6 ACH. However, infectious variant XBB.1.16 gave another wave of infection, 10,000 a day, in Hong Kong. Problems encountered in crowded gathering places without adequate ventilation are discussed. Owners can take two actions proposed earlier voluntarily and advertise that their ventilation provision is adequate. These are on display the instantaneous energy use on ventilation operation and carbon dioxide levels at indoor stagnant positions. Consumers can then have a choice.

1. Introduction

With the COVID-19 calming down, many gathering regulations are removed in Hong Kong [1-3]. The important issue of providing 6 ACH in gathering places [4] is no more required. There is no more control on wearing masks, or isolating infected persons. Many gathering places are obviously having inadequate ventilation provisions [5,6], but overcrowded. A very infectious omicron subvariant XBB.1.16 or “Arcturus” was found to have landed in Hong Kong in May 2023 with many people, including a government expert [7-9] on COVID-19 control infected. The Emergency Section of Hospital Authority is 24 hours operated, with number of infections over 10,000 a day. This might be labelled as the 6th wave of infection [10]. The subvariant is not so toxic, only 7% of infected persons had serious symptoms.

Leaders must be responsible to their staff and family members, only allowing necessary gathering with appropriate safety precautions. If more toxic and infectious variants than XBB.1.16 are found, the public healthcare systems might be overloaded as observed before. Lockdown might then be needed, though economic impact is a big issue. The tourist industry, catering services and airlines business might be seriously affected again.
2. Key Points on Relaxing Ventilation Requirement

The 6 ACH ventilation requirement appears to be relaxed in many gathering places including restaurants [4]. Relaxing 6 ACH requirement in catering areas should be watched because customers are eating with masks taken off. It is too expensive to keep and monitor whether 6 ACH is provided as reported [5].

The ventilation rate requirement of 6 ACH for COVID-19 spread control in gathering places including restaurants [4,11] is now removed. As demonstrated before, many restaurants had inadequate ventilation provision of 2 ACH as observed, with some even 0 ACH. Virus can be transmitted within a short time under this ventilation rate.

Direct air transmission of common virus was suspected to be possible under inadequate rate [12-20], though not yet been confirmed. As reported in the literature [21-23], the virus is carried by respiratory droplets and then transmitted by air. Such droplets are not distributed uniformly in most of the gathering places.

In minimizing airborne transmission, ventilation provision with adequate ventilation requirement, the Wells-Riley (WR) infection model [24,25] was used to work out the required number of air changes per hour ACH on virus control indoors. The probability $P$ of infection risk for a susceptible is expressed in terms of the air change rate $Q$ through a parameter $A$ by:

$$P = 1 - e^{-A/Q}$$  \hspace{1cm} (1)

There are very few experimental data for the novel coronavirus SARS-CoV-2 [26-29]. $P$ is plotted against $Q$ as reported before [5,6] and shown in Fig. 1. The data are fitted with Eq. (1) to yield $A = 0.8054$ hr$^{-1}$, with a very low correlation coefficient of 0.4621. Values of $P$ fluctuate for $Q$ less than 5 ACH, but at low values over 5 ACH. Therefore, using 6 ACH is reasonable to give low $P$. 
3. **Action to Consider**

Keeping indoor ventilation rate at 6 ACH has led to challenges, particularly from the catering industry. Ventilation requirements for buildings had been reviewed [30] by including indoor air flow pattern for developing ventilation codes. Local air speeds and turbulence are the key factors affecting virus transmission and can be predicted by Computational Fluid Dynamics (CFD) [31-42].

The ventilation rate cannot be measured quickly. Running the ventilation system to keep 6 ACH is very expensive. Two actions were proposed [5] to be considered:

- Installing an energy use meter [43,44] to the mechanical ventilation system will show whether the system is operating properly.
- Carbon dioxide concentration will be very high for inadequate ventilation rate. Measuring transient concentration of carbon dioxide at appropriate indoor stagnant positions by CFD supported by field measurement can estimate the instantaneous ventilation rate based on the well-mixed model in a suitable region [31].

It is difficult to implement those two actions by regulations as before. However, the owner can do it voluntarily as advertisement. They can display the instantaneous ventilation energy uses and carbon dioxide level to indicate their gathering places are properly ventilated. The consumers then can have a choice to have appropriate service at their affordable price.

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**Fig. 1: \( P \) Vs \( Q \) (Chow et al. 2021)**

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P = 1 - e^{-0.8054/Q}
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4. Discussion

Relaxation of requirements appears to be based on observed trends of infection number and the consequences [45]. However, the consequences at the moment are not so serious, The public healthcare systems are heavily loaded [46], but not so serious as in March, 2022. Markets like catering and tourists which are seriously disturbed due to blocking have to be resumed normal.

Further, insurance coverage is another concern [47]. Infecting more people with COVID-19 everyday would lead to direct or indirect effects on normal operation of the work force. Interaction of staff directly would infect colleagues. Families infected would affect staff too. Those infection citizens with or without symptoms might take place in series, not in parallel.

Low punishment on general safety incidents as in the Crane Tower incident 2007 [48] would lead to reluctance to invest properly on safety management. Increasing the fine to HK$10 million might be better [49-52]. People responsible for safety should have more to do.

On the other hand, business has to keep moving, for credits and might be for survival. But with such infectious variants coming in through traveling, even limited, still over having thousands of citizens confirmed infection everyday in Hong Kong until December 2022. Such a high infection number stands for several months.

After studying relevant data and discussing with affected or infected persons, wearing masks and/or adequate ventilation is the key. For crowded gathering places in HKSAR to watch are:

- Pre-educational systems for children below 6 and crowded tutorial classes in small rooms.
- Elderly caring halls.
- Restaurants without cleaning thoroughly after serving a table, inadequate ventilation below 6 ACH. Some might even shut down the ventilation to give 0 ACH.
- Private parties with many friends in small rooms.
- Public transport.

5. Conclusion

Two actions are proposed to demonstrate ventilation rate in a gathering place is adequate. Firstly, energy use meters reading to demonstrate that ventilation system is turned on, and using energy required. Secondly, showing the carbon dioxide level at critical positions determined by CFD are low, indicating adequate ventilation provisions. The gathering places owners to advertise themselves that adequate ventilation rates of 6 ACH is provided by displacing 2 key
parameters. It is difficult to implement stringent monitoring now, in order not to affect normal operation of business. The proposal can be a voluntary action for consumers to select.

References


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