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Quick Guide to the Virus-Tool

Use instructions for the virus tool (version 2) to estimate the virus load in a room

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Summary

This short guide explains the settings and results of the tool and gives practical tips for its use.

The tool estimates the concentration of viruses and CO_2 in a room with perfect mixing for one or more people emitting viruses in the form of aerosols. The tool also indicates the resulting virus dose for the other people in the room.

Possible settings for ...

the room:	size, outdoor air supply rate, flow rate of air cleaning devices, number of people in the room, initial CO_2-level, air velocity
the virus emitter:	mask type, emitter type, speech volume, physical activity, duration in the room
the receiver:	critical dose, mask type, physical activity, number of repetitions of the scenario

The most important results are visualised in the form of graphs. They show the time course of virus dose and CO_2 levels in the room in the first two hours.

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Step 1: Download tool

The "Virus Tool" is an Excel file. It can be downloaded free of charge in several language versions[1]. This manual was created for version 2.

Download at https://scoeh.ch/en/tools-en/

The original version of this tool was published in the scientific journal Aerosol and Air Quality Research. In version 2 there are some additional settings, results and graphs.

Recommended Citation:
Riediker, M. and Monn, C. (2020). Simulation of SARS-CoV-2 Aerosol Emissions in the Infected Population and Resulting Airborne Exposures in Different Indoor Scenarios. Aerosol Air Qual. Res. https://doi.org/10.4209/aaqr.2020.08.0531

Step 2: Enter information in sheet "Indoor Tool"

The following explanations help to define the input parameters, which can be entered in the turquoise fields on the sheet "Indoor-Tool":

Information about the room

Room volume	The volume can be estimated from length * width * height in meters. If there is a lot of closed furniture in the room, their volume should be deducted.
Air exchange rate	This value indicates how often the air volume is "renewed". To do this, divide the supply air rate by the room volume. Example: 300 m^3/h supply air to a room with volume of 100 m^3 -> air change rate is 3 /hr.
Supply of outside air	In the case of *mechanical ventilation*, this value can be requested from the building operator (housekeeper, technical service). Modern ventilation systems are often designed for 30 m^3 per person and hour. In case of *natural ventilation via windows and doors*, one can either... a) Measure the CO_2 course to determine the air exchange rate b) Estimate the air exchange rate as follows: 0.1 / hour = good sealing windows, door closed 0.3 / hour = Leaky windows, door closed 1.0 / hour = Tilted windows, door closed 3 to 20 / hour = Cross ventilation (windows and doors fully open)[2]
Recirculated air	This additional "air exchange" indicates how much air is cleaned by highly efficient air cleaners or similar (CADR: Clean Air Delivery Rate). The air remains in the room. The viruses are removed, but not the CO_2.
People in the room[3]	Infants (before kindergarten) can be counted as 1/2 adults, larger children as 2/3 adults. Teenagers should be counted in full.

[1] The tool is licensed under the Creatives Commons License 4.0 and may be freely used, modified and redistributed as long as credit is given. For details see https://creativecommons.org/licenses/by/4.0/deed.en
[2] The efficiency of cross ventilation depends strongly on the spatial situation. It works best when there are openings to the outside on all sides of the room (e.g. corridor with open windows).
[3] Note: the number of people in the room has only an indirect influence on the number of viruses. The more people in the room, the higher the probability that one of them is infected.

Information about the virus-emitter

Duration	How many minutes the virus-emitting person stays in the room.
Person is...	Here, a pull-down menu can be used to select how strongly the infected person emits viruses. When determining whether a room is "safe", a "super-emitter" should always be assumed. With the Delta variant, approximately one in two is a "high emitter", and also "super-emitters" have become quite frequent.
Type of mask	The type of mask can be selected with the pull-down menu. Green text below this field explains the mask type. In spaces to which the general public has access, it is often advisable to assume "ill-fitting masks".
Physical activity	Specify here the physical activity of the virus-emitting person. The proportion of "resting" activity is calculated automatically as soon as you specify the % of the time someone is lightly or heavily active.
Soft and loud speech	Specify here how much the virus-emitting person speaks. The proportions of "Quiet" are calculated automatically as soon as you specify how many % of the time someone speaks softly or loudly.

Information to be provided in the "Results" section

Mask of the others	Here the type of mask that the exposed person wears can be selected with a pull-down menu. The same mask types can be selected as for the virus-emitting person.
Critical number of viruses	This number refers to the number of virus copies determined by PCR technology. Not all copies are replicable viruses. In addition, not every virus can successfully penetrate a cell. For healthy persons, there is a realistic risk of infection from 300 virus copies. For persons at risk, a value of 30 virus copies is recommended.
Repetitions/day	This specification is used to calculate the total dose for several repetitions of a scenario. Example school: A class has six lessons of 45 minutes each on one day.

Step 3: Interpretation of the results

Viruses (region with blue background)

The model gives as a result both, virus concentrations and virus doses. What are these values used for? How can they be interpreted?

Far field	All results on the "Indoor Tool" sheet refer to the so-called "far field", i.e. the area of the room that is not in the direct vicinity of the emitting person.
Virus concentration	This figure tells how many viruses are suspended in the air at any given time. It can provide experts such as occupational hygienists with valuable information on risk management.

Virus dose	The dose indicates how many viruses in total were inhaled during the scenario under consideration. This provides information on the contribution of the scenario to a person's risk of infection.
Repetitions	Those who repeat the same scenario several times a day experience an increase in the total dose with each repetition. In addition to this "total dose", there are also doses from other scenarios. Example: In addition to multiple exposures at school, a person may receive additional doses during travel, during meals, etc.
Graph	The graph shows the course of the inhaled virus dose in the first two hours. If the virus-emitting person leaves the room before this time, the curve flattens out. This is because the virus concentration drops after leaving and less virus is inhaled. A red line indicates the "critical dose" (which can be defined in the field above the graph).

CO_2 (region with green background)

The model gives estimates of the CO_2 levels in the room. CO_2 can be used in a room to estimate the efficiency of ventilation. In combination with the virus dose, it is also possible to investigate how low the CO2 should remain so that the virus dose remains below the critical dose.

The estimation of this model is based on simplified assumptions. Measuring devices also have an uncertainty. Even good equipment can quickly deviate 15% from the "real" value. Note also that the model assumes that all persons have the same activity as the virus-emitting person.

CO_2 when leaving	This specification gives the CO_2 value in the room at the time when the virus-emitting person leaves the room.
Concentration after ...	These figures indicate for the first 60 minutes how much the CO_2 in a room increases with the specified ventilation values and the number of people in the room (in steps of 15 minutes). These figures assume that the number of persons in the room is constant.

Step 4: Print or save the results

The spreadsheets are set up so that the results fit on one printed page. A PDF or paper document can thus be quickly created to document the simulation and the settings made. Remember to print also the sheet "More settings and results" if you adjusted values on that sheet.

Further settings and results for experts

On the sheet "More settings & results" there is the possibility for experts to adjust further settings and to extract more results.

Additional results

Near-field results	In the vicinity of a person (the near field) the aerosol concentration is higher. This aspect is taken into account in the tool with a two-zone model. In the tool, the near field is the zone within 60 cm of the emitting person's head. Just as for the room, concentration and dose are given as result.

Dose for basic types	Dose is given for three basic types of activity (quiet, light, and heavy physical activity). This allows the calculation of the dose when an exposed person has a different activity than the virus-emitting person.

Additional settings

Mean air velocity	This setting influences the results in the near field. It is a setting variant for rooms with turbulent conditions. The assumption of a well-mixed room also applies to the near-field estimates. The model is **not** directly applicable to situations with directional airflow (e.g., fan blowing air directly to the emitting person).
CO_2 value at start	This setting affects the CO_2 results on the Indoor Tool sheet. In the default state, it is assumed that the CO_2 value at the beginning corresponds to the environmental concentration (currently 400 ppm). However, it may happen that the initial value is higher. Attention, after a break without ventilation not only the CO2 but also the virus concentrations are higher. This is not taken into account here and the virus level would have to be calculated manually!
Additional virus carriers	This setting affects all virus results on both sheets, on the Indoor Tool sheet and on this sheet. With these settings, the presence of up to four virus-emitting persons can be simulated. The values of the first infected person are taken from the sheet "Indoor-Tool". The others can be defined here.
Mask type in near field	This setting affects the dose in the near field on this sheet. The dose of a person in the near field depends on the type of mask in the same way as for persons in the far field. Attention, in the near field also large aerosols ("droplets") can transmit the virus if no masks are worn.

Raw data, formulas and modifications

The "Data" sheet contains numerous raw data, formulas and basic settings. These should not be changed by normal users. Developers are welcome to edit the tool. Please document the changes you have made. We are also grateful for tips and hints on how to further improve the tool.