AirCoV2

Risk calculator for aerosol tra

5.1.2e *

5.1.2e *

5.1.2e

5.1.2e

5.1.2e

5.1.2e

*shared first author

AirCoV2 - 24082020

AirCoV2 Risk calculator for aerosol transmission of SARS-CoV2

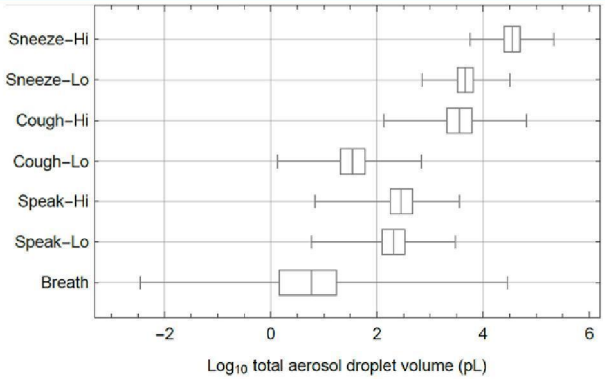
- Uitbreiding blootstellingscenario's met
  - Besmettelijke persoon en blootgestelde personen tegelijkertijd in de binnenruimte
  - Afmetingen ruimte
  - Aantallen blootgestelde personen
  - Verblijfsduur
  - Ventilatie
  - Fractie intacte virusdeeltjes
  - Fractie infectieuze virusdeeltjes
- Interactieve rekentool
- Output
  - Concentratie virusdeeltjes in de binnenruimte als functie van de tijd
  - Cumulatieve dosis
  - Kans op blootstelling/infectie van tenminste één persoon

AirCoV2 model

- Constante toename aantal virusdeeltjes door besmet personen ten gevolge van uitademen/spreken (lineaire toename)
- Door één keer hoesten of niesen een bepaalde beginconcentratie van virusdeeltjes in de lucht
- Virusdeeltjes verdwijnen met een bepaalde snelheid (exponentiele afname)
  - Inactivatie van het virus
  - Ventilatie
  - Inademing door blootgestelde personen
- Dosis
  - Cumulatieve dosis over de verblijfsduur
  - Exponentiele dosisresponsrelatie
- Aanname
  - Gelijkmatige verdeling van de virusdeeltjes in de binnenruimte

AirCoV2 data

- Verdelingen van gemeten aerosolen met initiële diameter ≤ 60µm; totale volume; literatuurgegevens



- Concentraties SARS-CoV2 in mucus (RIVM PCR metingen)
  50% $\geq 10^5$/ml; 20% $\geq 10^7$/ml; 5% $\geq 10^8$/ml
- Fractie intacte virusdeeltjes 0.6, Lednickey et al. (2020),
  Viable SARS-CoV-2 in the air of a hospital room 1 with COVID-19 patients 2-5m away from patients
  See also Santarpia et al. (2020)

Table 3. Estimate of viable virus counts based on $TCID_{50}$ tests.

Sample ID	Virus genome equivalents/L of air[a]	$TCID_{50}$/100 µl	Viable virus count/L air
1-1 BioSpot	94	2.68E+04	74
1-2 BioSpot + HEPA	-	0	0
1-3 BioSpot	30	6.31E+03	18
2-1 VIVAS	44	1.00E+04	27
2-2 VIVA S+ HEPA	-	0	0
2-3 VIVAS	16	2.15E+03	6

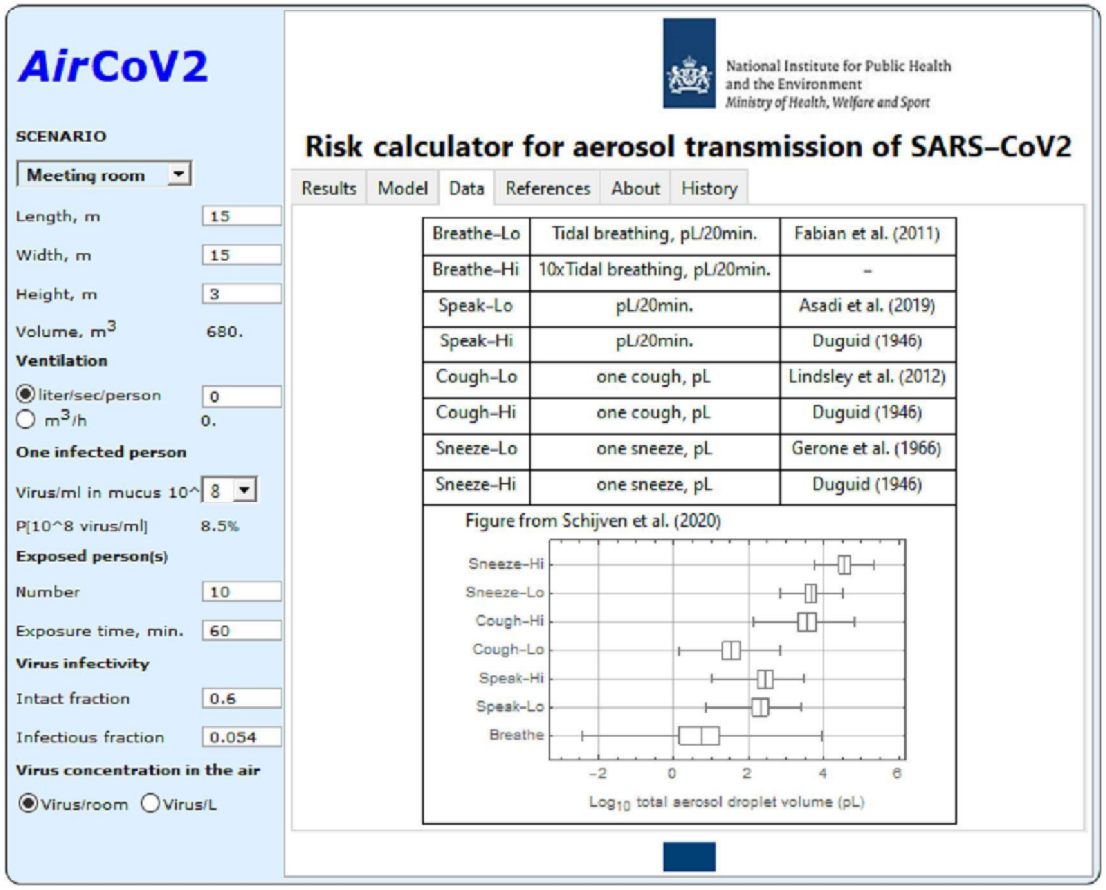
[a]From Table 2.

AirCoV2 aannames

- Virusconcentratie in aerosol druppels = virusconcentratie in mucus
- Gelijkmatige verdeling van de virusdeeltjes in de binnenruimte
- Hoog infectieus virus, exponentiele dosisrespons, r=0,054, α-coronavirus 229E (Watanabe et al., 2010, Haas, 2020)

*Air*CoV2

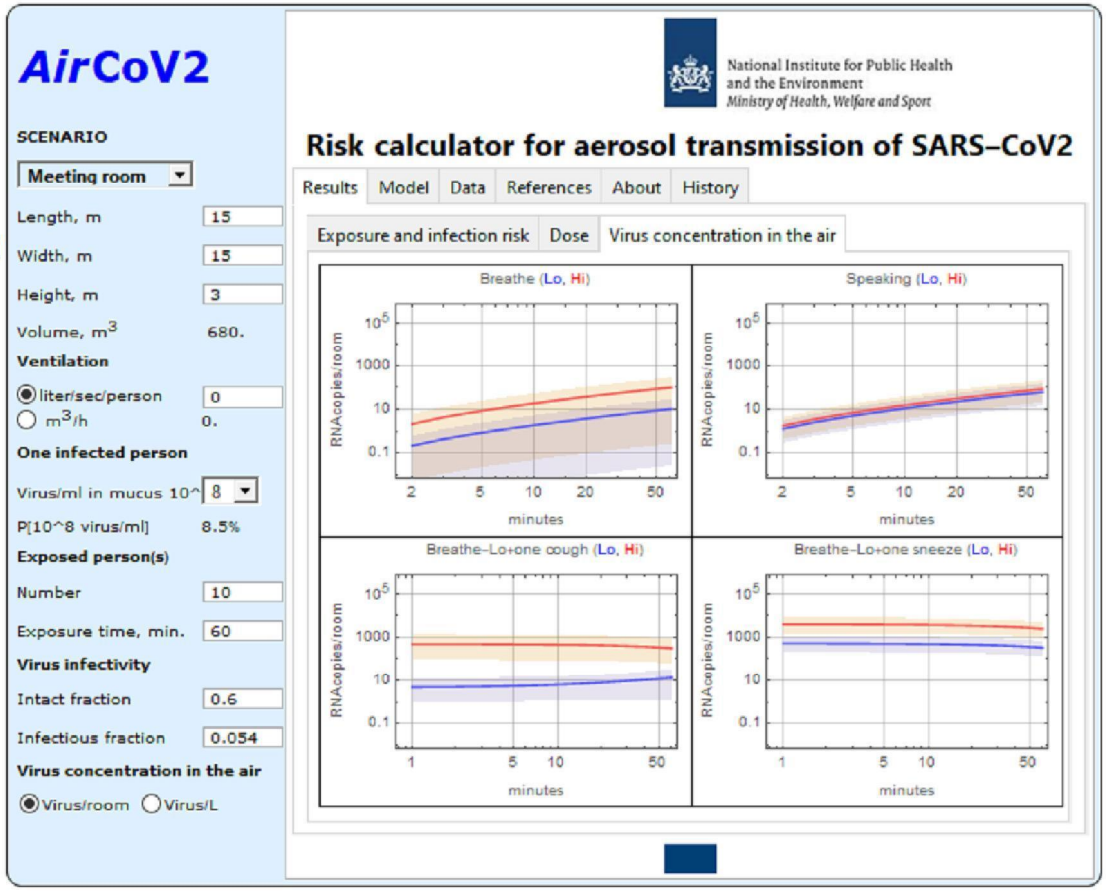
- Scenario
  - Ruimte: l x b x h
  - Ventilatie
  - Eén besmettelijke persoon met bepaalde virusconcentratie (10^2-10^{11} per ml)
  - Aantal blootgestelde personen en verblijfsduur
  - Virus infectiviteit



Breathe–Lo	Tidal breathing, pL/20min.	Fabian et al. (2011)
Breathe–Hi	10xTidal breathing, pL/20min.	-
Speak–Lo	pL/20min.	Asadi et al. (2019)
Speak–Hi	pL/20min.	Duguid (1946)
Cough–Lo	one cough, pL	Lindsley et al. (2012)
Cough–Hi	one cough, pL	Duguid (1946)
Sneeze–Lo	one sneeze, pL	Gerone et al. (1966)
Sneeze–Hi	one sneeze, pL	Duguid (1946)

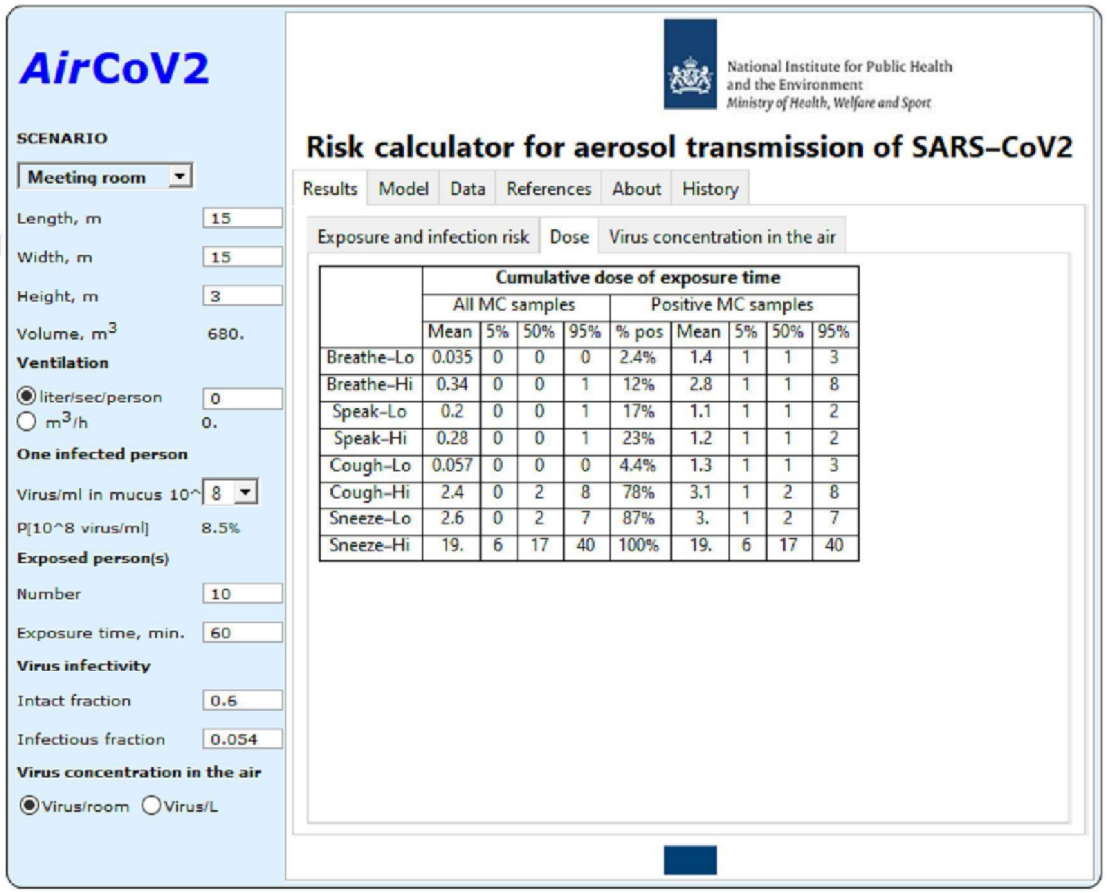
*Air*CoV2

- Vergadering
- Geen ventilatie
- Tien+één personen
- Duurt één uur



*Air*CoV2

- Vergadering
- Geen ventilatie
- Tien+één personen
- Duurt één uur



Cumulative dose of exposure time

	All MC samples				Positive MC samples				
	Mean	5%	50%	95%	% pos	Mean	5%	50%	95%
Breathe-Lo	0.035	0	0	0	2.4%	1.4	1	1	3
Breathe-Hi	0.34	0	0	1	12%	2.8	1	1	8
Speak-Lo	0.2	0	0	1	17%	1.1	1	1	2
Speak-Hi	0.28	0	0	1	23%	1.2	1	1	2
Cough-Lo	0.057	0	0	0	4.4%	1.3	1	1	3
Cough-Hi	2.4	0	2	8	78%	3.1	1	2	8
Sneeze-Lo	2.6	0	2	7	87%	3.	1	2	7
Sneeze-Hi	19.	6	17	40	100%	19.	6	17	40

*Air*CoV2

- Vergadering
- Geen ventilatie
- Tien+één personen
- Duurt één uur

AirCoV2

SCENARIO

Meeting room

Length, m	15
Width, m	15
Height, m	3
Volume, m^3	680.

Ventilation

liter/sec/person	0
m^3/h	0.

One infected person

Virus/ml in mucus 10^	8
P[10^8 virus/ml]	8.5%

Exposed person(s)

Number	10
Exposure time, min.	60

Virus infectivity

Intact fraction	0.6
Infectious fraction	0.054

Virus concentration in the air

Virus/room Virus/L

National Institute for Public Health and the Environment
Ministry of Health, Welfare and Sport

Risk calculator for aerosol transmission of SARS–CoV2

Results | Model | Data | References | About | History

Exposure and infection risk | Dose | Virus concentration in the air

	Exposure probability				Infection risk			
	Mean	5%	50%	95%	Mean	5%	50%	95%
Breathe–Lo	1.2%	0%	0%	0%	0.11%	0%	0%	0%
Breathe–Hi	7.1%	0%	0%	45%	0.89%	0%	0%	3.2%
Speak–Lo	8.4%	0%	0%	45%	0.63%	0%	0%	3.2%
Speak–Hi	12%	0%	0%	45%	0.9%	0%	0%	3.2%
Cough–Lo	2.2%	0%	0%	0%	0.18%	0%	0%	0%
Cough–Hi	56%	0%	70%	99%	7.2%	0%	6.3%	23%
Sneeze–Lo	64%	0%	70%	99%	7.9%	0%	6.3%	20%
Sneeze–Hi	99%	97%	100%	100%	43%	18%	42%	73%

Probability of exposing and infecting at least one person via aerosol transmission of virus from one infected person.

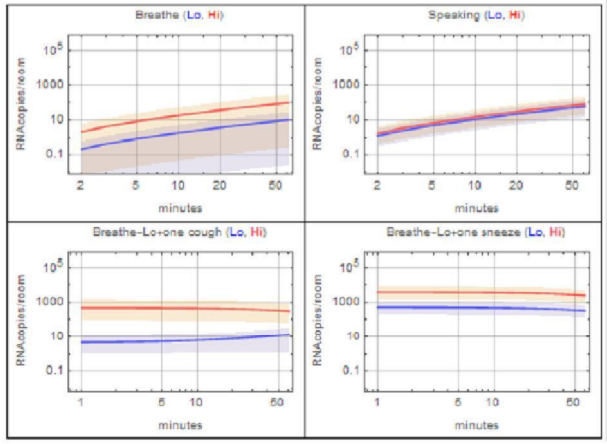
Exposure probability and infecting risk are equal if the fractions of intact virus particles and of virus particles giving infection are both equal to one.

The probability of this scenario occurring depends on the prevalence of the virus infection and the frequency of persons meeting in this kind of room for this period of time.

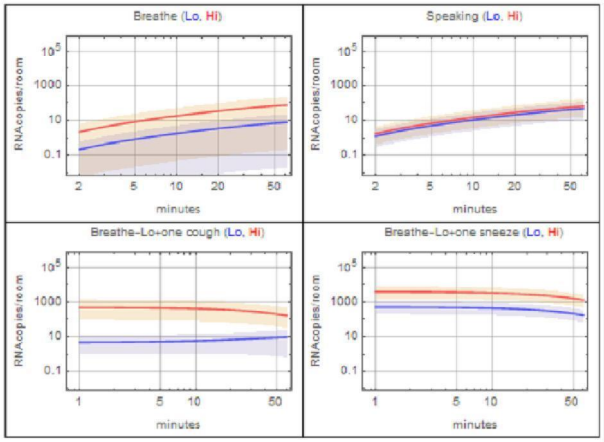
Concentratie virusdeeltjes in de lucht

- Vergadering
- Tien+één personen
- Duurt één uur
- 1: geen ventilatie
- 2: 12 L/s/p=432m3/uur=0,1xruimte/10min.
- 3: 120 L/s/p=432m3/uur=1xruimte/10min.

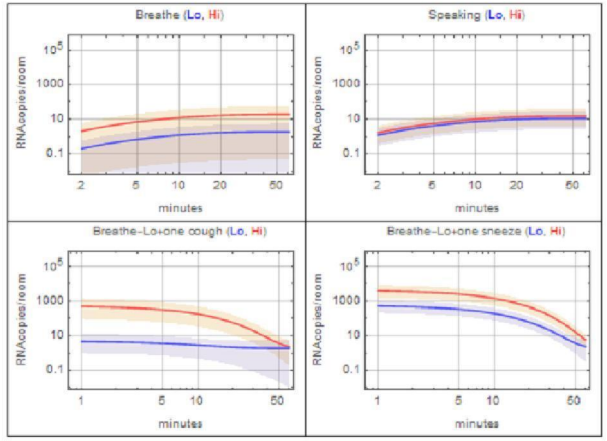
1



2



3



Cumulatieve dosis

- Vergadering
- Tien+één personen
- Duurt één uur
- 1: geen ventilatie
- 2: 12 L/s/p=432m3/uur=0,1xruimte/10min.
- 3: 120 L/s/p=432m3/uur=1xruimte/10min.

1	Cumulative dose of exposure time								
	All MC samples				Positive MC samples				
	Mean	5%	50%	95%	% pos	Mean	5%	50%	95%
Breathe-Lo	0.035	0	0	0	2.4%	1.4	1	1	3
Breathe-Hi	0.34	0	0	1	12%	2.8	1	1	8
Speak-Lo	0.2	0	0	1	17%	1.1	1	1	2
Speak-Hi	0.28	0	0	1	23%	1.2	1	1	2
Cough-Lo	0.057	0	0	0	4.4%	1.3	1	1	3
Cough-Hi	2.4	0	2	8	78%	3.1	1	2	8
Sneeze-Lo	2.6	0	2	7	87%	3.	1	2	7
Sneeze-Hi	19.	6	17	40	100%	19.	6	17	40

2	Cumulative dose of exposure time								
	All MC samples				Positive MC samples				
	Mean	5%	50%	95%	% pos	Mean	5%	50%	95%
Breathe-Lo	0.029	0	0	0	2%	1.4	1	1	4
Breathe-Hi	0.28	0	0	1	11%	2.6	1	1	7
Speak-Lo	0.17	0	0	1	15%	1.1	1	1	2
Speak-Hi	0.24	0	0	1	20%	1.2	1	1	2
Cough-Lo	0.047	0	0	0	3.7%	1.3	1	1	3
Cough-Hi	1.8	0	1	6	70%	2.6	1	2	7
Sneeze-Lo	1.9	0	2	5	80%	2.4	1	2	6
Sneeze-Hi	15.	4	13	31	100%	15.	4	13	31

3	Cumulative dose of exposure time								
	All MC samples				Positive MC samples				
	Mean	5%	50%	95%	% pos	Mean	5%	50%	95%
Breathe-Lo	0.011	0	0	0	0.97%	1.1	1	1	2
Breathe-Hi	0.093	0	0	1	5.1%	1.8	1	1	5
Speak-Lo	0.063	0	0	1	5.9%	1.1	1	1	2
Speak-Hi	0.078	0	0	1	7.4%	1.1	1	1	2
Cough-Lo	0.013	0	0	0	1.1%	1.2	1	1	2
Cough-Hi	0.44	0	0	2	31%	1.4	1	1	3
Sneeze-Lo	0.48	0	0	2	36%	1.3	1	1	3
Sneeze-Hi	3.5	0	3	8	92%	3.8	1	3	9

Blootstelling en infectierisico

- Vergadering
- Tien+één personen
- Duurt één uur
- 1: geen ventilatie
- 2: 12 L/s/p=432m3/uur=0,1xruimte/10min.
- 3: 120 L/s/p=432m3/uur=1xruimte/10min.

1	Exposure probability				Infection risk			
	Mean	5%	50%	95%	Mean	5%	50%	95%
Breathe-Lo	1.2%	0%	0%	0%	0.11%	0%	0%	0%
Breathe-Hi	7.1%	0%	0%	45%	0.89%	0%	0%	3.2%
Speak-Lo	8.4%	0%	0%	45%	0.63%	0%	0%	3.2%
Speak-Hi	12%	0%	0%	45%	0.9%	0%	0%	3.2%
Cough-Lo	2.2%	0%	0%	0%	0.18%	0%	0%	0%
Cough-Hi	56%	0%	70%	99%	7.2%	0%	6.3%	23%
Sneeze-Lo	64%	0%	70%	99%	7.9%	0%	6.3%	20%
Sneeze-Hi	99%	97%	100%	100%	43%	18%	42%	73%

2	Exposure probability				Infection risk			
	Mean	5%	50%	95%	Mean	5%	50%	95%
Breathe-Lo	1%	0%	0%	0%	0.089%	0%	0%	0%
Breathe-Hi	6.1%	0%	0%	45%	0.73%	0%	0%	3.2%
Speak-Lo	7.3%	0%	0%	45%	0.54%	0%	0%	3.2%
Speak-Hi	9.9%	0%	0%	45%	0.75%	0%	0%	3.2%
Cough-Lo	1.8%	0%	0%	0%	0.15%	0%	0%	0%
Cough-Hi	47%	0%	45%	97%	5.5%	0%	3.2%	18%
Sneeze-Lo	54%	0%	70%	95%	5.9%	0%	6.3%	15%
Sneeze-Hi	98%	91%	100%	100%	35%	12%	34%	63%

3	Exposure probability				Infection risk			
	Mean	5%	50%	95%	Mean	5%	50%	95%
Breathe-Lo	0.46%	0%	0%	0%	0.035%	0%	0%	0%
Breathe-Hi	2.8%	0%	0%	45%	0.27%	0%	0%	3.2%
Speak-Lo	2.8%	0%	0%	45%	0.2%	0%	0%	3.2%
Speak-Hi	3.4%	0%	0%	45%	0.25%	0%	0%	3.2%
Cough-Lo	0.53%	0%	0%	0%	0.04%	0%	0%	0%
Cough-Hi	17%	0%	0%	70%	1.4%	0%	0%	6.3%
Sneeze-Lo	19%	0%	0%	70%	1.5%	0%	0%	6.3%
Sneeze-Hi	74%	0%	83%	99%	10%	0%	9.3%	23%

Conclusies

- Voor het scenario in een niet geventileerde vergaderruimte (680m^3) met 11 personen, waarvan 1 besmettelijk gedurende een uur, virusconcentratie in aerosol = die in mucus = 10^8/ml (5%):
  - Ademen/spreken leidt via aerosoltransmissie tot een infectierisico van ongeveer 1%
  - Een nies of een hoest leidt via aerosoltransmissie tot een zeer hoog infectierisico
- Volgens het model is effect ventilatie van 12 liter/sec/persoon verwaarloosbaar
- Volgens het model is effect ventilatie van 120 liter/sec/persoon 3-4 x reductie infectierisico