



Arbeidshygiëne in een pandemie:  
Voorkomen van Covid-19

# Rol van mondkmaskers en ventilatie in het Covid-19 maatregelenpakket



NVVA Landelijke Contact Bijeenkomst  
Digitale bijeenkomst 10 december 2020

5.1.2e

# Introduction

- Covid-19 working group



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## Info over het coronavirus voor Arboprofessionals

Het coronavirus leidt tot veel vragen bij arboprofessionals. Essentieel is nu dat wij allen samenwerken om de kennis die nodig is voor arbeidshygiënist, zo snel mogelijk beschikbaar te stellen.

Op deze pagina's bieden wij de bronnen gerangschikt naar enkele thema's. Het doel is dat hiermee de arboprofessionals achtergrond info beschikbaar hebben, waarmee zij hun adviezen kunnen vormgeven. Dit betekent dat iedereen zelf verantwoordelijk blijft voor de opgestelde adviezen.

Let er ook op dat er constant voortschrijdend inzicht is. Check daarom de meest actuele versie van de informatie waarnaar in deze webpagina's verwezen wordt.

Graag ontvangen wij aan- en opmerkingen bij deze informatie. Ook indien je nieuwe informatie hebt dan ontvangen wij die graag, opdat we dit voor iedereen beschikbaar kunnen stellen. Stuur je reactie aan [nvva@arbeidshygiene.nl](mailto:nvva@arbeidshygiene.nl)

## Elements in this presentation

- Covid-19 (general aspects)
- Respiratory Protective Equipment (general aspects)
- Respiratory protection in hospital settings
- Respiratory protection in the general community
- Potential role of aerosol transmission
- Thoughts on the role of ventilation

# Covid-19: some general aspects

Transmission routes of respiratory viruses:

## 1. Contact transmission

- Direct contact with an infectious person (e.g. handshake)
- Contact a contaminated surface (hand to mouth, nose, eyes)

## 2. Droplet transmission

- Respiratory droplets by infectious person (e.g. sneezing, coughing)
- Close to an infected person

## 3. Airborne transmission

- Smaller droplets and particles
  - Greater distance
  - Remain suspended in the air for longer time

CDC, 2020a

## Covid-19: some general aspects

Consensus on relevant routes of transmission:

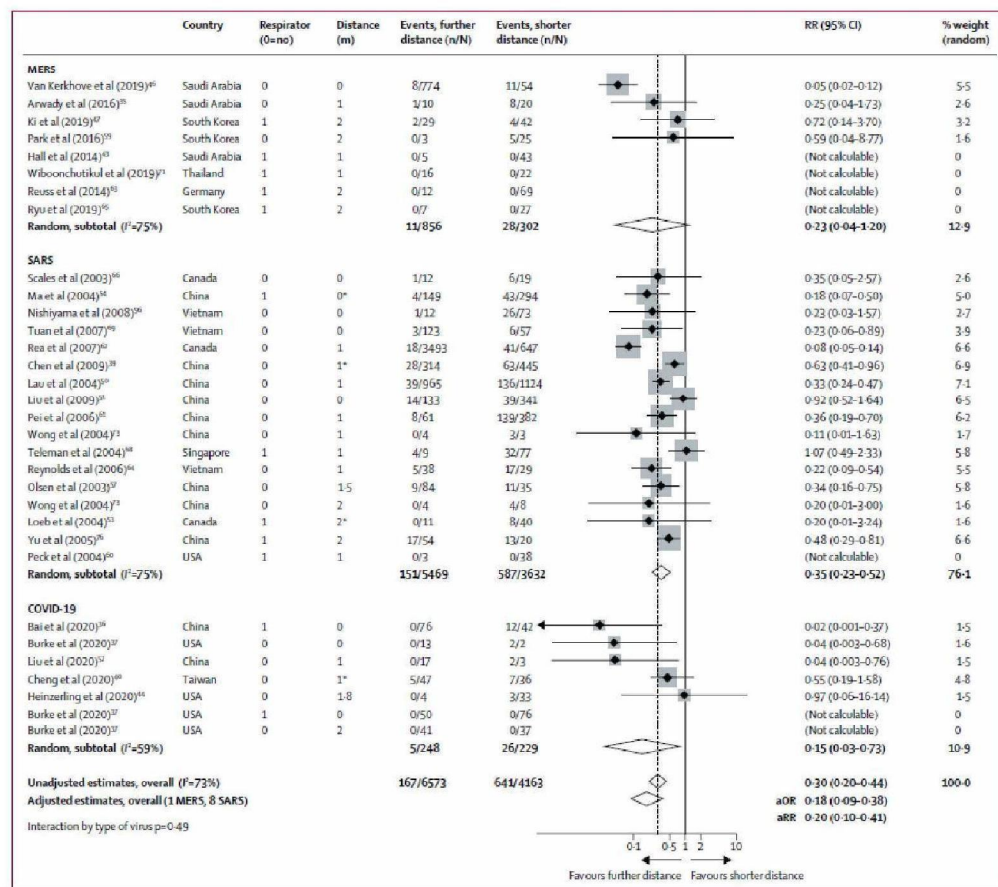
1. Contact transmission — YES
2. Droplet transmission — YES
3. Airborne transmission
  - Aerosol generating procedures in hospitals — YES
  - Aerosols in the general (indoor) environment — Under debate

CDC, 2020a; WHO, 2020

## Covid-19: some general aspects

### General preventive measures

1. Stay home when complaints or tested positive
2. Physical distancing (1-2 meters)
3. Frequent hand hygiene
4. Sneeze and cough in your elbow
5. Try not to touch your face



# Physical distancing: the evidence

- Systematic review and meta-analysis
- 1 meter or more compared with < 1m:
- Pooled adjusted odds ratio 0.18 (95% CI 0.09-0.38)
- Strength of association larger with increasing distance

Chu et al, 2020

## Covid-19: some general aspects

### General preventive measures

1. Stay home when complaints or tested positive
2. Physical distancing (1-2 meters)
3. Frequent hand hygiene
4. Sneeze and cough in your elbow
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**What about respiratory protection?**

## Covid-19: some general aspects

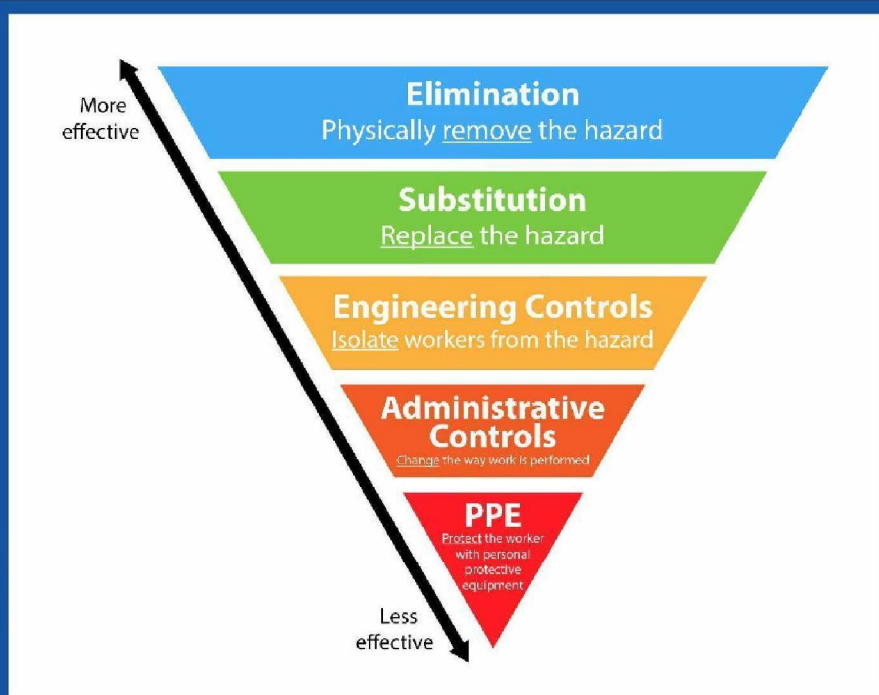
### General preventive measures

1. Stay home when complaints or tested positive
2. Physical distancing (1-2 meters)
3. Frequent hand hygiene
4. Sneeze and cough in your elbow
5. Try not to touch your face
6. Respiratory protection:
  - Health worker with care for Covid-19 patients
  - In hospital settings with aerosol generating procedures
  - In settings where a physical distancing cannot be achieved

} Further specifications and nuancing in next slides

CDC, 2020a; WHO, 2020

## Respiratory protection (general aspects)



I need to say it...

- Personal protective equipment the last step in the occupational hygiene strategy
- **Respiratory protection only in combination with other control measures!!!**



# Respiratory protection (general aspects)

## TYPES OF RESPIRATORY PROTECTION



**Elastomeric Half Facepiece Respirators** are reusable and have replaceable cartridges or filters. They cover the nose and mouth and provide protection against gases, vapors, or particles when equipped with the appropriate cartridge or filter.



**Elastomeric Full Facepiece Respirators** are reusable and have replaceable canisters, cartridges, or filters. The facepiece covers the face and eyes, which offers eye protection.



**Filtering Facepiece Respirators** are disposable half facepiece respirators that filter out particles such as dusts, mists, and fumes. They do NOT provide protection against gases and vapors.



**Powered Air-Purifying Respirators (PAPRs)** have a battery-powered blower that pulls air through attached filters, canisters, or cartridges. They provide protection against gases, vapors, or particles, when equipped with the appropriate cartridge, canister, or filter. Loose-fitting PAPRs do not require fit testing and can be used with facial hair.



**Supplied-Air Respirators** are connected to a separate source that supplies clean compressed air through a hose. They can be lightweight and used while working for long hours in environments not immediately dangerous to life and health (IDLH).



**Self-Contained Breathing Apparatus (SCBAs)** are used for entry into or escape from environments considered to be IDLH. They contain their own breathing air supply and can be either open circuit or closed circuit.



**Combination Respirators** can be either a supplied-air/SCBA respirator or supplied-air/air-purifying respirator. The SCBA type has a self-contained air supply if primary airline fails and can be used in IDLH environments. The air-purifying type offers protection using both a supplied-air hose & an air-purifying component and cannot be used for entry into IDLH environments.

For Covid-19 **disposable** respirator masks seems to be the most logical choice

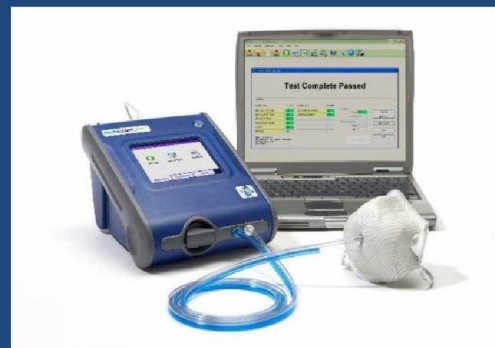
Most **tight-fit** respirators: a good fit to the face skin is needed

## Respiratory protection (general aspects)

- Respiratory Protection Programme including fit-testing

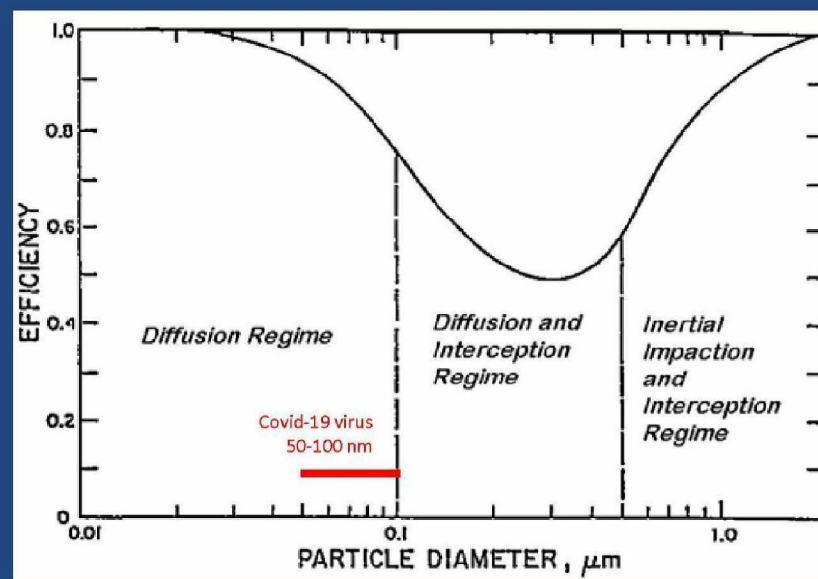
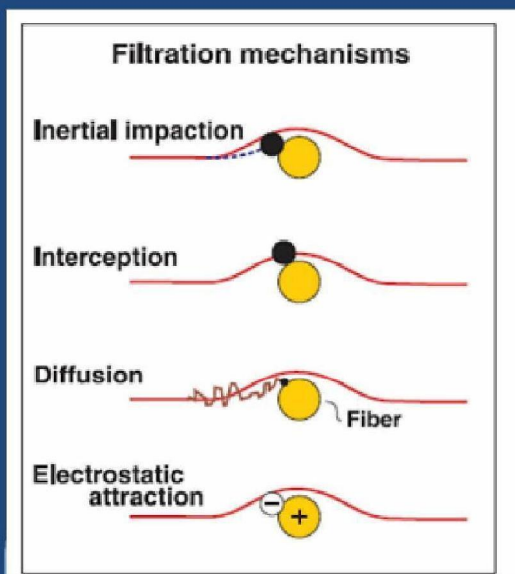


Qualitative fit test  
(smell)



Quantitative fit test  
(sampling inside & outside)

## Filter efficiency



Covid-19 virus will be transported as part of a droplet/aerosol

NIOSH, 2009

## Protection factor of filtering facepieces

**Table 1. Efficiency requirement for filtering facepieces and their assigned protection factors**

Class	Max permitted total inward leakage	Max permitted filter penetration	Min filter efficiency <sup>□□</sup>	Nominal Protection Factor <sup>††</sup>	Assigned Protection Factor
FFP1	22%	20	80%	4.5	4
FFP2	8%	6	94%	12.5	10
FFP3	2%	1	99%	50	20

□□ Figure derived from the maximum filter penetration allowed by BS EN 149:2001

□□□ Figure derived from the maximum total inward leakage allowed by BS EN 149:2001

## Outside Europe

**Table 1** Comparison of key requirements of N95, FFP2 and FFP3 respirators.

Requirement	N95 (NIOSH-42CFR84)	FFP2 (EN149:2001+A1:2009)	FFP3 (EN149:2001+A1:2009)
Assigned Protection factor (APF)	10	10	20
Filter efficiency	≥95% (85 l/min)	≥94% (95 l/min)	≥99% (95 l/min)
Test agent used	NaCl	NaCl and Paraffin oil	NaCl and Paraffin oil
Total inward leakage (TIL)	N/A	≤8%	≤2%
Inhalation resistance	≤343 Pa (85 l/min)	≤240 Pa (95 l/min)	≤300 Pa (95 l/min)
Exhalation resistance	≤245 Pa (85 l/min)	≤300 Pa (160 l/min)	≤300 Pa (160 l/min)

Not exactly the same (slightly different test protocols, but FFP2 ≈ N95 (US) ≈ P2 (down under) ≈ KN95 (China))








HSE, 2020

# Respiratory protection (general aspects)

Mostly tight-fit

Loose-fit

**TYPES OF RESPIRATORY PROTECTION**

 <p><b>Electrostatic Non-Filtrating Respirators (ENFR)</b> Respirators are made of non-woven polypropylene or other synthetic fibers. They cover the nose and mouth and provide protection against gases, vapors, or particulates. They do not have an assigned protection factor.</p>	 <p><b>Electrostatic Non-Filtrating Respirators (ENFR)</b> Respirators are made of non-woven polypropylene or other synthetic fibers. They cover the nose and mouth and provide protection against gases, vapors, or particulates. They do not have an assigned protection factor.</p>	 <p><b>Filtering Facepiece Respirators (FFR)</b> are designed to filter out particles that enter the nose and mouth. They do not provide protection against gases and vapors.</p>	 <p><b>Powered Air-Purifying Respirators (PAPR)</b> have a battery-powered blower that pushes air through a filter. They can be used for protection against gases, vapors, or particulates when equipped with the appropriate cartridge, canister, or filter. Loose-fitting PAPRs do not require fit testing and can be used with larger hoods.</p>
 <p><b>Supplied-Air Respirators</b> are connected to a separate source that supplies clean compressed air through a hose. They can be supplied and used while working for long hours in environments not immediately life-threatening (SCBA).</p>	 <p><b>Self-Contained Breathing Apparatus (SCBA)</b> are used for entry into or rescue from environments considered to be IDLH. They contain their own supply of air and can be either open circuit or closed circuit.</p>	 <p><b>Combination Respirators</b> can be either a supplied-air SCBA respirator or a supplied-air purifying respirator. The SCBA type has a tank containing an supply of primary air and can be used in IDLH environments. The air-purifying type contains a filter or canister and can be used in IDLH environments.</p>	

EDC Center  
September 2019



Fluid-resistant medical mask (type IIR)

Test protocols (EN-14683)



Non-medical masks or cloth masks

No test protocols

Intended to protect the wearer from particles in the environment

Respiratory protection equipment (with an assigned protection factor)

Intended to protect the environment (patients) from particles expelled by the wearer

No respiratory protection equipment (no protection factor assigned)

Question: what protection do they offer?

## Valved versus non-valved



Provides the same level of protection to the wearer

Exhalation valves reduces the exhalation resistance  
But: exhaled air is released unfiltered: no protection for patients

# Advice on the use of masks in the context of COVID-19

Interim guidance

5 June 2020

## Health care settings

- By voting of Guidance Development Group
- Taking into account practical considerations (disadvantages of full-time use of respirators)



Respirator  
(FFP2, FFP3, N95)

- In care settings where aerosol generating procedures (AGPs) are performed (e.g. Covid-19 intensive and semi-intensive care units)

Fluid-resistant  
medical mask

- Direct care to Covid-19 patients in the absence of AGPs

WHO, 2020

# Advice on the use of masks in the context of COVID-19

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Respirator  
(FFP2, FFP3, N95)

- In care settings where aerosol generating procedures (AGPs) are performed (e.g. Covid-19 intensive and semi-intensive care units)

- **Defined AGP list in most countries** (WHO: tracheal intubation, non-invasive ventilation, tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, bronchoscopy, sputum induction induced by using nebulized hypertonic saline, and autopsy procedures)
- **Potential of release of small particles that range > 1-2 meters and stay in the air longer**
- **Potential of airborne transmission**

WHO, 2020

# Advice on the use of masks in the context of COVID-19

Interim guidance

5 June 2020

## Health care settings

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If not a respirator....

Is it protective for the health worker?

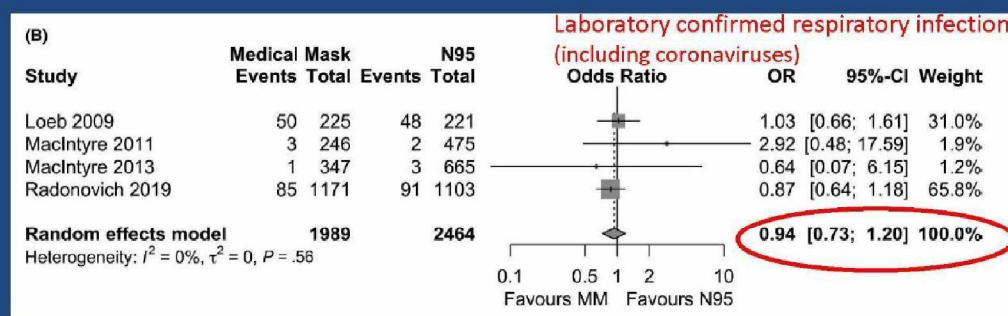
Yes: based on  
randomised  
clinical trials

Fluid-resistant  
medical mask

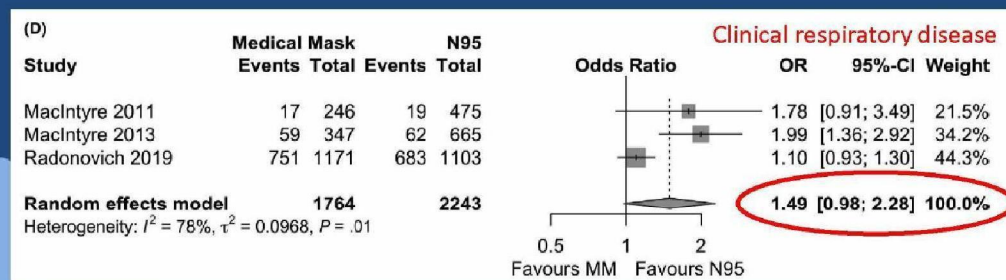
- Direct care to Covid-19 patients in the absence of AGPs

WHO, 2020

## Systematic review and meta-analysis of randomized controlled trials (RCTs)

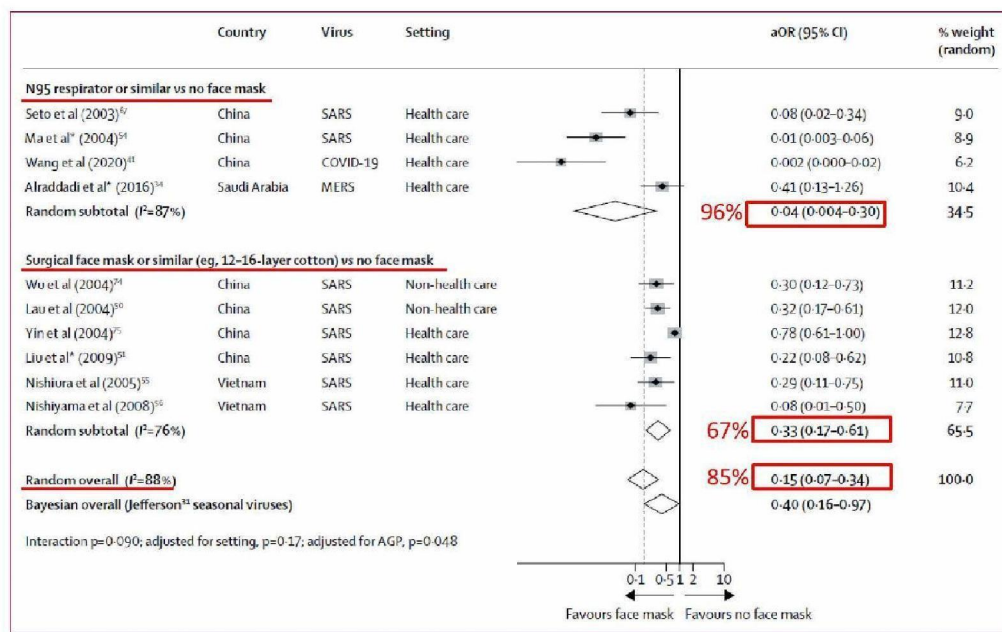


- Not statistically different
- Medical masks and N95 respirators offer similar protection during non-aerosol-generating care



Similar results for laboratory confirmed influenza infection and influenza like illness

Bartoszko et al, 2020 (& Long et al, 2020)



# Face mask use: the evidence

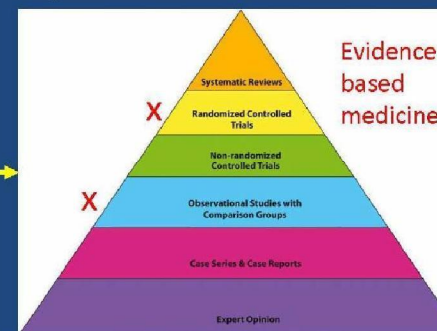
- Systematic review and meta-analysis
- Any face mask versus no face mask:
- Pooled adjusted odds ratio 0.15 (95% CI 0.07-0.34)

## Study suggests better performance for N95 vs medical masks

However:

1. Mix of surgical mask and cotton masks
2. Observational studies only (no randomised controlled trials)

Chu et al, 2020



## Recent study suggests community transmission is more important than hospital transmission

### COVID-19 in health-care workers in three hospitals in the south of the Netherlands: a cross-sectional study



Reina S Sikkema\*, Suzan D Pas\*, David F Nieuwenhuijse, Áine O'Toole, Jaco J Verweij, Anne van der Linden, Irina Chestakova, Claudia Schapendonk, Mark Pronk, Pascal Lexmond, Theo Bestebroer, Ronald J Overmars, Stefan van Nieuwkoop, Wouter van den Bijllaardt, Robbert G Bentvelsen, Miranda M L van Rijen, Anton G M Buiting, Anne J G van Oudheusden, Bram M Diederer, Anneke M C Bergmans, Annemiek van der Eijk, Richard Molenkamp, Andrew Ramboul, Aura Timen, Jan A JW Kluytmans, Bas B Oude Munnink, Marjolein F Q Kluytmans van den Bergh\*, Marion P G Koopmans\*



Lancet, Vol 20, Nov 2020

- Research among 95 SARS-CoV-2 positive health-care workers in 3 hospitals in the early phase of the epidemic (feb/march 2020)
- Combination of epidemiologic data with whole-genome sequencing (determining the source of each infection)
- Consistent with multiple introductions through community-acquired infections
- **Does not support nosocomial infections**
- **In hospitals use of medical mask (except for AGPs)**

Sikkema et al, 2020

## Non-medical masks for the general public

### Advice on the use of masks in the context of COVID-19

Interim guidance  
5 June 2020

**Note:**

Only in addition to the general measures for Covid-19 prevention!!



**No direct evidence of effectiveness but risk-based approach:**

Use masks in geographical areas with known or widespread transmission (high prevalence)

- in public settings (e.g. grocery stores, churches)
- In situations with high population density
- Settings where physical distancing cannot be achieved (e.g. public transportation)

WHO, 2020

## Filtration efficiency of non-medical masks

- Highly varies between cloth fabrics and masks (0-99%)
- Efficiency increases with multiple layers
- Expected: Reduction in infection rate and/or severity of infection

REVIEW

### Studies between 1978-2020



Check for updates

#### Forgotten Technology in the COVID-19 Pandemic: Filtration Properties of Cloth and Cloth Masks—A Narrative Review

Catherine M. Clase, MB; Edouard L. Fu, BSc; Aumeen Ashur;

**General conclusion: cloth masks may prevent transmission of Covid-19**

- Cloth can block droplets and aerosols, and layers add efficiency
- Many materials tested, e.g.:
  - Cotton cloth: 43-94% filter efficiency
  - T-shirts/touwels: 10-40% filter efficiency

However: no standardised testing so  
uncertainty in effectiveness

Some guidance in recent NEN-spec (nov 2020)

WHO, 2020; Clase et al 2020a&b); Peeples, 2020, NEN, 2020

## Community use of masks effective?

- CDC Scientific Brief November 2020
  - Multi-layer cloth mask can:
    - Block up to 70% of fine droplets and aerosol particles
    - Limit the spread of those particles that do penetrate the mask
  - Prevention benefit of masking is derived from the **combination** of source control and personal protection for the mask wearer

## Community use of masks effective?

Citing a number of studies that are strongly in support of reduced spread of Covid-19 when wearing masks:

- 2 hair stylist with symptoms and confirmed Covid-19: none of the 67 clients developed infection
- 124 households with  $\geq 1$  Covid-19 positive person: further household spread was reduced by 79%
- Military personell working in aircraft carrier: masking was associated with 70% reduced risk of infection
- Investigations of airline flights >10 hours that had covid-19 infected passengers: none of the other passengers and crew developed infections < 14 days
- 7 other studies: new infections declined significantly after introduction of rule to use masks on a community level

CDC, 2020b; Mitze et al 2020

## Covid-19: some general aspects

Consensus on relevant routes of transmission:

- |                   |  |              |
|-------------------|--|--------------|
|                   | 1. Contact transmission                        | YES          |
| > 5 $\mu\text{m}$ | 2. Droplet transmission                        | YES          |
| < 5 $\mu\text{m}$ | 3. Airborne transmission                       |              |
|                   | – Aerosol generating procedures in hospitals   | YES          |
|                   | – Aerosols in the general (indoor) environment | Under debate |

CDC, 2020a; WHO, 2020

## Emission of small aerosols in the absence of aerosol generating procedures (AGPs)



### Small aerosols

Reach longer distances  
Stay in the air longer

Do they play a significant role in  
the Covid-19 epidemic?

### Large droplets

Deposit close to the person

## Arguments in favour of a significant role

- It has been shown that sneezing, coughing, talking, singing,.... **also emit smaller aerosols**
- It has been shown that such **particles can travel far** and stay in the air long
- Air sampling in clinical settings in the absence of AGPs **found Covid-19 virus RNA** in some settings (but not in others)
- **Some disease clusters** have been presented that suggest a possible role of small aerosols (e.g. choirs)

CDC, 2020a; WHO, 2020; Klompas et al 2020, RIVM 2020

## Arguments not in favour of a significant role

- The **estimated reproduction number of around 2,5** is not in favour of airborne transmission (diseases that spread through airborne transmission tend to have higher attack rates like measles)
- Also, the **secondary attack rate** is low both in the general public and among health care workers (only about 5% of contacts of patients with confirmed Covid-19 become infected)
- If aerosol transmission would be dominant, **respirators would be more protective than medical masks**
- If aerosol transmission would be dominant, **the protective effect of distancing would be limited**
- There is **no evidence of efficient spread** to people far way or who enter a space hours after an infectious person was there
- Air sampling in clinical settings in the absence of AGPs **dit not found virus RNA** in some settings (but did in others)
- Most studies that did found virus RNA **have not shown viable** infectious virus (the presence of viral RNA does not prove aerosol-based transmission)

CDC, 2020a; WHO, 2020; Klompas et al 2020, RIVM 2020


## Overall considerations

- It cannot be concluded that aerosol-based transmission never occurs
- Available data indicate that SARS-CoV-2 spread like most other common respiratory viruses, **primarily through respiratory droplets**
- The balance of currently available evidence suggest that long-range **aerosol-based transmission is not the dominant mode of transmission** (like measles)
- However, airborne transmission **can be relevant in special circumstances** (as exception to the general rule)
  - Enclosed spaces
  - Prolonged exposure to respiratory particles generated with expiratory exertion (e.g. shouting, singing, exercising)
  - Inadequate ventilation (accumulation in time)

CDC, 2020a; WHO, 2020; Klompas et al 2020, RIVM 2020

## What does this mean?

### General preventive measures


1. Stay home when complaints or tested positive
2. Physical distancing (1-2 meters)
3. Frequent hand hygiene
4. Sneeze and cough in your elbow
5. Try not to touch your face
6. Respiratory protection
7. Ventilation 

- Only in addition to the general control measures (less important than 1-6)
- Ventilation will have little or no impact on droplet or contact transmission
- Follow the existing rules of room ventilation (e.g. ventilation rates)

### Personal opinion:

- Proper ventilation is good from a general perspective and can also contribute to reduce covid-19 infections, but is not the most important action that needs to be taken.
- Ventilation is important but not more important since covid-19 (**don't make ventilation the most important thing to do**)

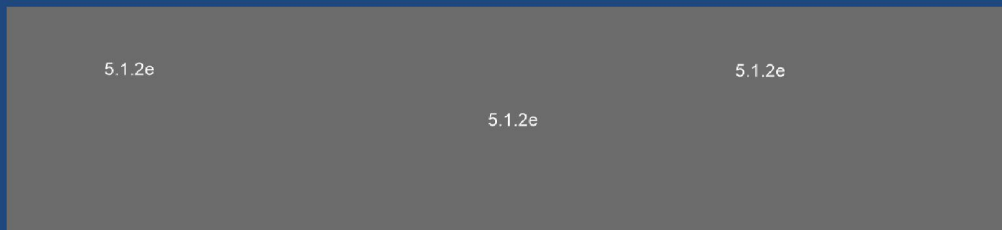
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In addition (in Dutch only): RIVM Medical guideline Covid-19 infection (including appendices)

## Who are we?

### NKAL




### IRAS



## Where can you find us?

[www.nkal.nl](http://www.nkal.nl)

 @nkal.nl



Universiteit Utrecht - Institute for Risk Assessment Sciences

