

Science-based evidence for wearing Masks In the public space during an epidemic of a virus with respiratory transmission.

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BELGIUM

Viña del Mar, Chile. Seeing how the epidemic evolved in Europe, a group of citizens of this town of 325,000 inhabitants, under the leadership of Dr Oneglio Pedemonte, a Belgium-trained anaesthesiologist, moved forward and convinced more than 90 % of the population to wear a mask, any kind of mask. Fifty days after the start of the epidemic the sole public hospital of the town had only admitted 8 Covid patients in its ICU of whom none had died and five already returned home, cured. (Personal Communication Dr O Pedemonte)

Second example of the efficacy of masks during the Covid-19 epidemic :

It is never too late to act : Jena, German city of 106 000 inhabitants, adopted wearing a facemask in public and at work at the date of April the 6th. Home-made masks because the municipality had none to give except to health professionals. On the 9th of April the hospital counted 155 Covid-19 patients; there has been no single Covid-linked admission since.

<https://www.france24.com/fr/20200424-le-port-du-masque-à-jéna-un-modèle-pour-l-allemande-dans-la-lutte-contre-le-covid-19>

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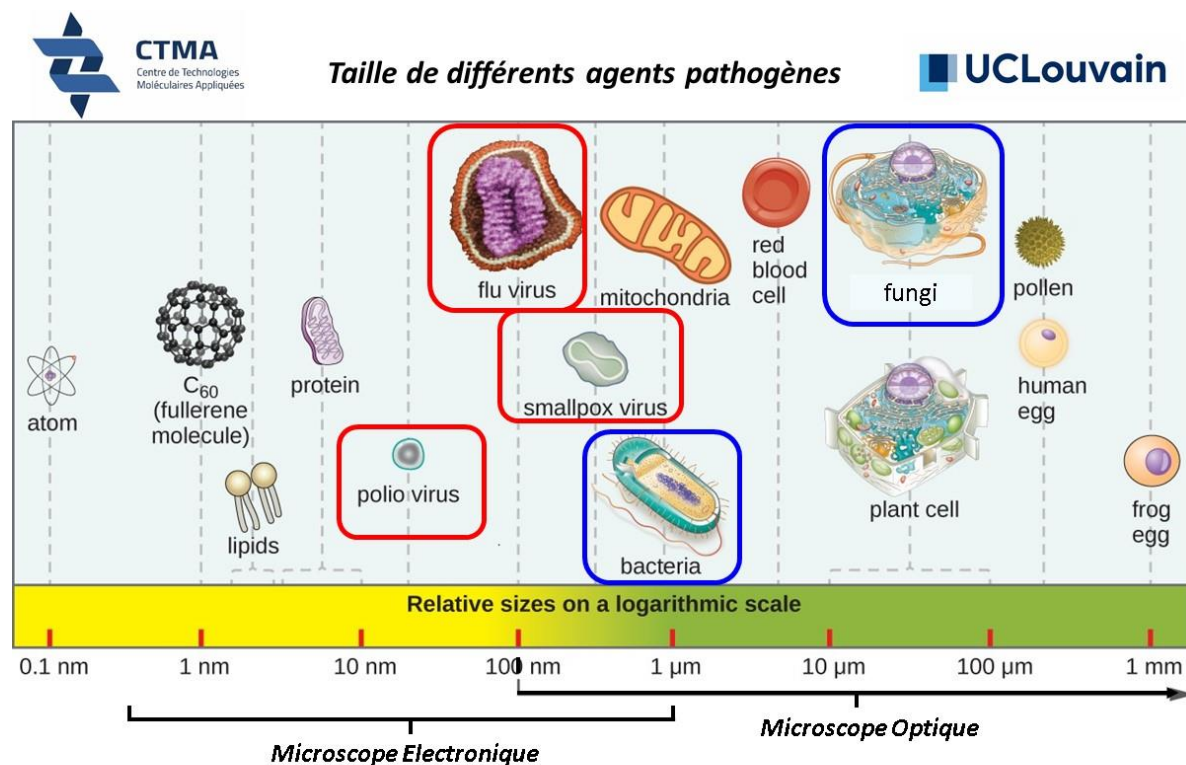
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What is a pathogen, what is a virus?

A pathogen is a cause of disease outside the body. It could be pollution, a toxin that is found in the environment, but the term is mostly used for living or life-associated forms. Their spread and severity depend on their *contagiousness* (propensity to be transmitted from human to human) and also on their *pathogenicity*, i.e. the severity of the resulting illness and complications.

- The most common pathogenic organisms that are alive or capable of reproduction are:
 - Flat worms called Plathelminths (e.g. tapeworm, taenia)
 - Unicellular parasites (e.g. plasmodium for malaria)
 - Bacteria, also called "microbes" or "germs" (e.g. staphylococcus from abscesses, or salmonella for typhoid fever, tuberculosis bacillus)
 - Viruses (e.g. measles, polio, chickenpox, HIV for AIDS, Ebola, dengue, zika, chikungunya...)
- The size of unicellular parasites varies widely. The figure compares pathogens with other living organisms or parts of them. The average size of viruses is between 20 (polio) and 250 (smallpox) nanometers (nm)¹. SARS-CoV-2, the virus causing Covid-19, measures 130 to 150 nm.



¹ One nanometer is one-thousandth of a micron, which is one-thousandth of a millimeter.

What is a virus?

- Viruses are **very small**: typically less than 0.25 micron (250nm). Viruses are not really living things: they are made up of a capsid (shell) containing their genetic material (the blueprint for making a copy of them). The capsid has characteristic parts by which the host recognizes that it is an intruder (these characteristics are called antigens).
- There are a wide variety of viruses. Not all viruses will cause disease: seawater is full of harmless viruses. But there are also many viruses responsible for illnesses: flu, measles, chickenpox, polio... **Coronaviruses** are a family of viruses that mainly cause mere colds but also serious illnesses, especially respiratory illnesses.
- Viruses are **unable to multiply by themselves**: they must parasitize another form of life (a cell or a bacterium) to which they inoculate their genetic material (DNA or RNA) that will "hijack" the host's genetic material to force it to make new viruses. Once full of viruses, the infected cell or bacterium bursts and releases the (hundreds of) viruses it has made. These new viruses will go on to infect other cells, or spread into nature and infect other individuals.
- The process of multiplication of a virus by a host is a risky one: errors in copying the genetic material often occur: the virus is said to mutate. Many of these mutations result in viruses that are unable to go on infecting, but others result in viruses that are able to infect but are no longer recognizable by the host immune system.
(see [What is an epidemic](#))
- To be able to penetrate a host cell the virus capsids are equipped with **docking systems** (the entry keys) that specifically recognize a piece of the host cell surface (the lock).
- Viruses are **unable to move on their own**: to infect another individual they need to be carried by air streams, water, or objects on which they have been deposited.

What is an epidemic?

- An **epidemic** occurs when a pathogen infects and makes a significant part of the population ill at a given time. E.g. seasonal flu caused by a virus. The transfer of the pathogen from one person to another is called **contagion**.
- Some viruses are transmitted by several means e.g. **in the air** (such as influenza, smallpox, measles, chickenpox or coronaviruses), through **fæces and dirty hands** (such as polio), through **blood** (such as hepatitis B, HIV-AIDS) or even through **objects** covered with viruses such as small scraps of skin (e.g. chickenpox). They can be transmitted by vectors such as mosquitoes (malaria, dengue, yellow fever, chikungunya), ticks... Larger animals can serve as hosts (rats for the plague, bats for coronaviruses).
- Contamination through the air occurs by breathing out, coughing or sneezing: viruses are either found in **droplets** of saliva, mini-droplets (**microdroplets**) or on much smaller particles that fly away on their own: these are called virus **aerosols**.
- Once infected by a virus our body reacts: it takes an imprint of the virus antigens and stores it in its memory: this is a role for specific blood cells. These cells will multiply, produce molecules able to both recognise and adhere to the virus (**antibodies**), and will pass the information on to other cells that in turn will attack the virus. This process is called **immunity**. Most often once this memory is developed, the individual remains able to recognise the virus for a long period of time, sometimes for his whole life even.
- A **vaccine** is the administration of a virus that has been killed or significantly weakened but has retained the characteristics that allow the body to recognise it and develop immunity against it.
- If most of the population has already encountered the virus or has already been vaccinated, the virus cannot easily find hosts to infect. It is said that there is **herd immunity** that protects the few individuals without immunity. But if there are many non-immunized individuals, an epidemic can burst out again. A severe measles outbreak occurred in 2018-2019 in a New York religious community that refuses vaccination.
- When one encounters a virus not much different from a virus we've already come across previously, our immunity triggers a response. But if the virus has mutated to the point where it is no longer recognizable, we then develop a disease.
- The World Health Organization (WHO) coordinates the screening of new viruses so as to incorporate them into new vaccines.
- **How long does it take to prepare a new vaccine?** (BBC documentary *Pandemic*) Once a new strain of a dangerous virus is identified, it takes the pharmaceutical industry an average of 4 months to prepare a new vaccine. However, to bring it to public use takes another 18 to 24 months depending on the difficulties encountered during the development and testing phases.

What is a pandemic? What is a pandemic virus?

- Definition: A pandemic is an epidemic that spreads around the world.
- A pandemic virus is a new virus to which no one is immune and which can therefore be transmitted anywhere in the world.
- Current opportunities are conducive to the occurrence of pandemics: mass travels, corporate relocations, globalization and interdependence of economies, trade growing intensity, etc.

How does a pandemic develop ? The BBC life-size experiment.

- **"BBC Pandemic"**: an initiative of the University of Cambridge and the London School of Hygiene and Tropical Medicine, led to two life-size experiments organized in 2018 by the BBC and based on geolocation of volunteers with their smartphone. The tracking of 500 volunteers in a small town showed that within 72 hours 86% of the town's population would be infected from a single patient zero. The second part of the experiment was based on the follow-up of more than 28,000 volunteers showed that in 4 months more than 43 million (65% of 66 million) Britons would be affected and more than 880,000 would die.
- ***The conclusion of this prophetic study was that the development of a pandemic would take place with extreme speed and would require very quick measures as soon as the first cases were detected, something that would be impossible without a well-established prior plan.***

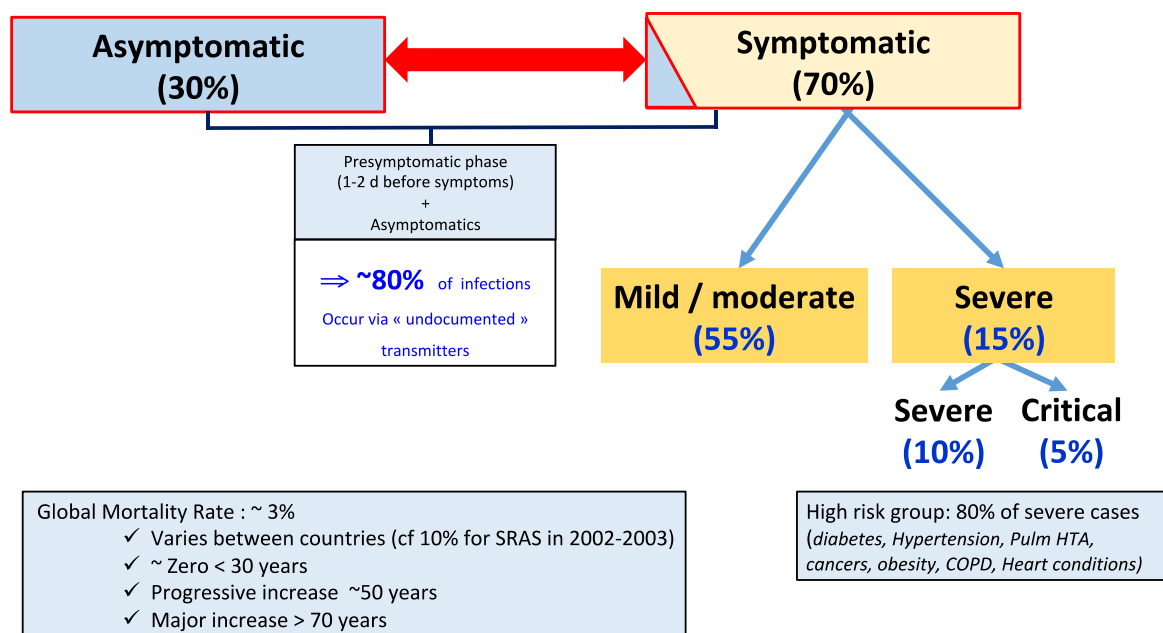
See summary of this TV programme at the end of the document

Modes of transmission of Coronavirus

- A study of data collected early in the COVID-19 epidemic in Hubei province, analysed by computer simulation, concludes that the rapid spread of the virus can only be explained by the assumption that almost **79% of the transmissions** that occurred before the province's borders were closed **occurred through "undocumented cases"** (Li). That is to say :
 - virus carriers before any symptoms (all cases, 1 to 5 days before symptoms)
 - mildly symptomatic (55%) or asymptomatic (30%) cases
 - cases attributed to seasonal influenza who prematurely returned to work.

Only 15% of cases are severe (10%) or critical (5%). 80% of severe or critical cases have one of the following preexisting conditions : hypertension, diabetes, heart condition, obesity, cancer, chronic obstructive pulmonary disease (COPD).

Li R Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV2). Science. 2020 Mar 16. pii: eabb3221. doi:10.1126/science.abb3221



- Given that for COVID-19, the **NOSE** is **both the gateway for the virus to enter the body and its primary source of spread** before even the patient becomes symptomatic, it is essential to establish the first line of defence at this level. This spread is very active several days before the carrier has the first symptoms of the disease. Wearing a citizen mask is therefore proposed as **a PRELIMINARY protection to the "barrier gestures" (hand washing, social distancing)** which are also essential elements in controlling the transmission of the virus.

Gandhi M, Yokoe S, Havlir D. Asymptomatic Transmission, the Achilles' Heel of Current Strategies to Control Covid-1. NEJM April 24, 2020 DOI: 10.1056/NEJMe2009758

Note: COVID-19 is different from previous coronaviruses (SARS and MERS) which were spread only by coughing from the lower airways once pulmonary infection was evidenced.

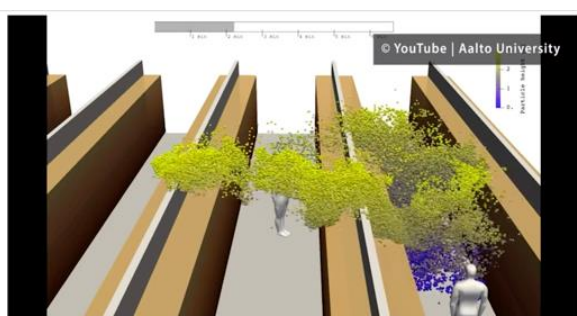
- **A Simple conversation** causes the emission of microdroplets at a distance that is totally prevented by the interposition of a single layer of tissue. It has been calculated that a one-second loud speech produces +/- 2600 microdroplets that evaporate within a few seconds so as to reach a size that allows them to remain airborne for 8 to 14 minutes as an aerosol. Depending on the viral load of saliva one minute of speech can produce between 1,000 and 100,000 such aerosolized virus-containing microdroplets. The length of person-to-person contact time required for contagion may therefore have been overestimated and the importance of conversation may have been underestimated; wearing a mask in public may limit such transmission.

- Fineberg. Rapid Expert Consultation on the Possibility of Bioaerosol Spread of SARS-CoV-2 for the COVID-19 Pandemic (April 1, 2020).

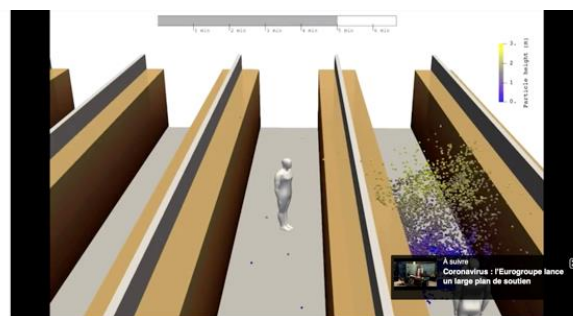
- Anfinrud, P., Stadnytskyi, V., Bax, C. E., & Bax, A. (2020). Visualizing Speech-Generated Oral Fluid Droplets with Laser Light Scattering. New England Journal of Medicine. <https://www.nejm.org/doi/full/10.1056/NEJMc2007800>

- Stadnytskyi V, Bax C, Bax A, Anfinrud Ph. The airborne lifetime of small speech droplets and their potential importance in SARS-CoV-2 transmission PNAS : May 13, 2020 <https://doi.org/10.1073/pnas.2006874117>

- A collaboration of 4 Finnish research institutes enabled a supercomputer simulation that showed the **aerosolised cloud** extends beyond 5 meters and persists for more than 5 minutes after a **simple dry cough** in a well-ventilated supermarket, even contaminating customers in adjacent aisles. (Vuorinen, University of Aalto, posted on the university's website on 6 April 2020). **Sneezing** has the same effect, only to an even greater distance.



Nebulised cloud 2 minutes after dry cough



Nebulised cloud 5 minutes after dry cough

<https://www.aalto.fi/en/news/researchers-modelling-the-spread-of-the-coronavirus-emphasise-the-importance-of-avoiding-busy>

Bourouiba L . Turbulent Gas Clouds and Respiratory Pathogen Emissions : Potential Implications for Reducing Transmission of COVID-19 JAMA on-line March 26, 2020

- See topic: *How long does COVID-19 remain in the environment?*

van Doremalen N, Bushmaker T. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1 ; N Engl J Med Letter 382;16 April 16, 2020 - Viability on objects :

- Airflow-dynamics studies, including studies performed with the use of computational fluid-dynamics and multizone modeling could show that the SARS-virus (also a coronavirus like that of Covid-19; SARS virus being named SARS-CoV-1, Covid-19 virus has been named SARS-CoV-2) could be transmitted by aerosols moving vertically between appartements via the bathrooms air-shafts. It provoked a local epidemic in a 19-store appartment building in Hong Kong (Yu). The same model also showed that the virus spread to two more buildings 60 meters down-wind. This epidemic spreading in the coumpoung called Amoy Gardens contaminated 187 poeple and became a landmark in the history of epidemiology, specifically that of coronaviruses. The subject who generated these particularly contaminant aerosols was very syptomatic and had an

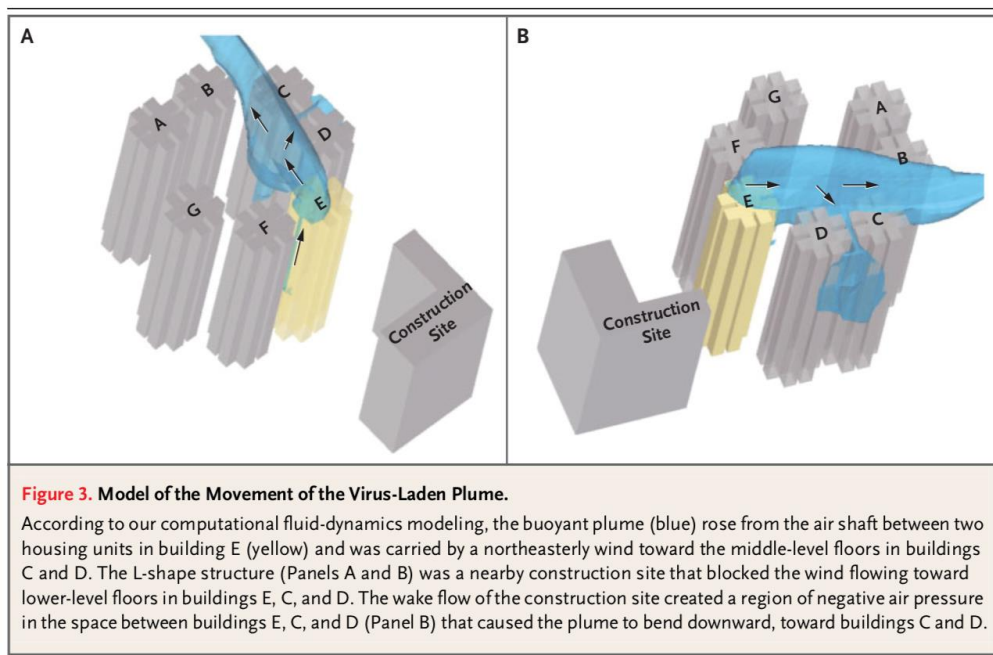
important virus load. This episode has questioned the traditional vision of coronaviruses-transmission that only considered short-distance saliva droplets. It demonstrated the possibility of long-distance airborne virus-loaded aerosols (Roy). The accompanying editorial concluded, prophetically :

As perplexing as it may be, the peculiarity of the transmission of the SARS coronavirus in Amoy Gardens may be a harbinger of unorthodox transmission patterns associated with emerging infectious agents in the modern built environment.

The authors cited commercial airplanes, hospital public spaces, schools...

A peculiarity of Covid-19 is the number of asymptomatic people who feature high viral loads (TC Jones, Berlin). One can not exclude that they unconsciously spread aerosol plumes over dozens of meters, especially in protected areas with air flows, similar to those already cited, but also in large shopping centers, theaters and rest houses. However, such aerosol contagions have not yet been proven for Covid-19.

- Yu IT, et al. Evidence of airborne transmission of the severe acute respiratory syndrome virus. *N Engl J Med*. 2004 Apr 22;350(17):1731-9.
- Roy, CJ Milton, DK Airborne transmission of communicable infection - the elusive pathway *N Engl J Med*. 2004 Apr 22; 350:1710 – 1712
- T. C. Jones et al. An analysis of SARS-CoV-2 viral load by patient age. May 1, 2020.
- Stability and Viability of SARS-CoV-2. Letters in reply to vanDoremalen *N Engl J Med* 2020 May 14; 382(20):1962-6.

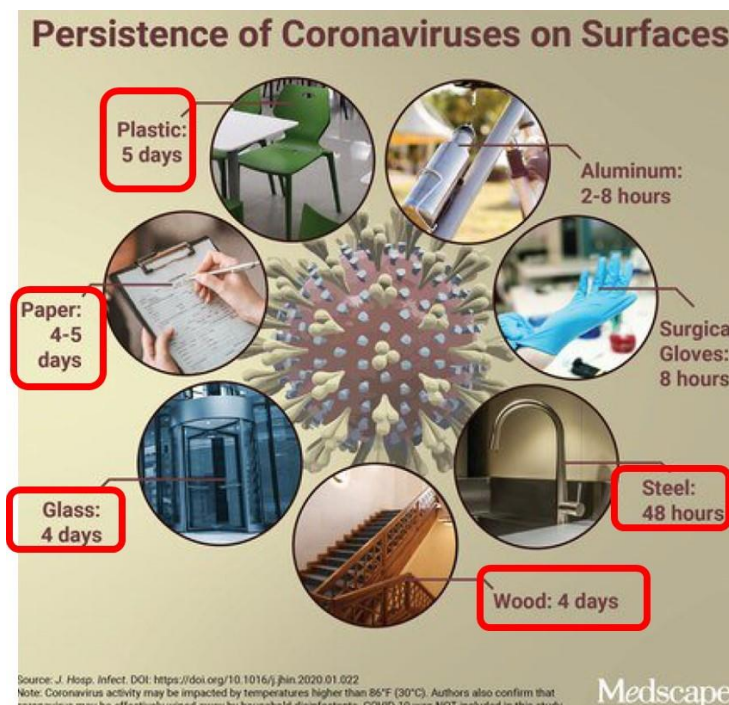


- Viability on objects: The actual removal process of Personal Protective Equipment (PPE) is associated with a significant spread of the virus. It is essential to follow a strict procedure to avoid contamination of the caregiver, the staff member handling the removed equipment or even the corridors and surrounding premises.

Wei Xiang Ong. Air, surface Environmental and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) from a Symptomatic Patient. *JAMA* online March 4, 2020

How long does COVID-19 remain stable in the environment?

- The most recent study on the subject was released on April 16, 2020. It compares the measurements made with the virus responsible for SARS and COVID-19 (renamed since SARS-2). The results are as follows: both viruses persist in the environment in a fairly similar way. Therefore, we will limit ourselves here to COVID-19.
 - In aerosols the virus remained in suspension for the whole duration of the experiment (3 hours) but with a rapid fall in viable viruses concentration. Computed half-life was 1.10 hour (confidence interval: 36 minutes to 2.40 hours).
 - The virus stays viable (although at a concentration a thousand times lower) up to 72 hours on steel or cardboard surfaces. It survives very poorly on copper surfaces (a natural antibacterial agent).



- The small differences recorded in the environmental survivability of both viruses (SARS 1 and 2) do not explain the differences in the spread of these two diseases. The cause must be looked for elsewhere: for example, the high viral loads of SARS-2 virus (=COVID-19) in the upper respiratory tract of infected patients and the potential for infected people to spread the virus for several days before having symptoms.
- These findings are important in developing strategies to prevent the transmission of the disease.

van Doremalen N, Bushmaker T. Aerosol and Surface Stability of SARS-CoV-2 as compared with SARS-CoV-1; N Engl J Med Letter 382;16 April 16, 2020

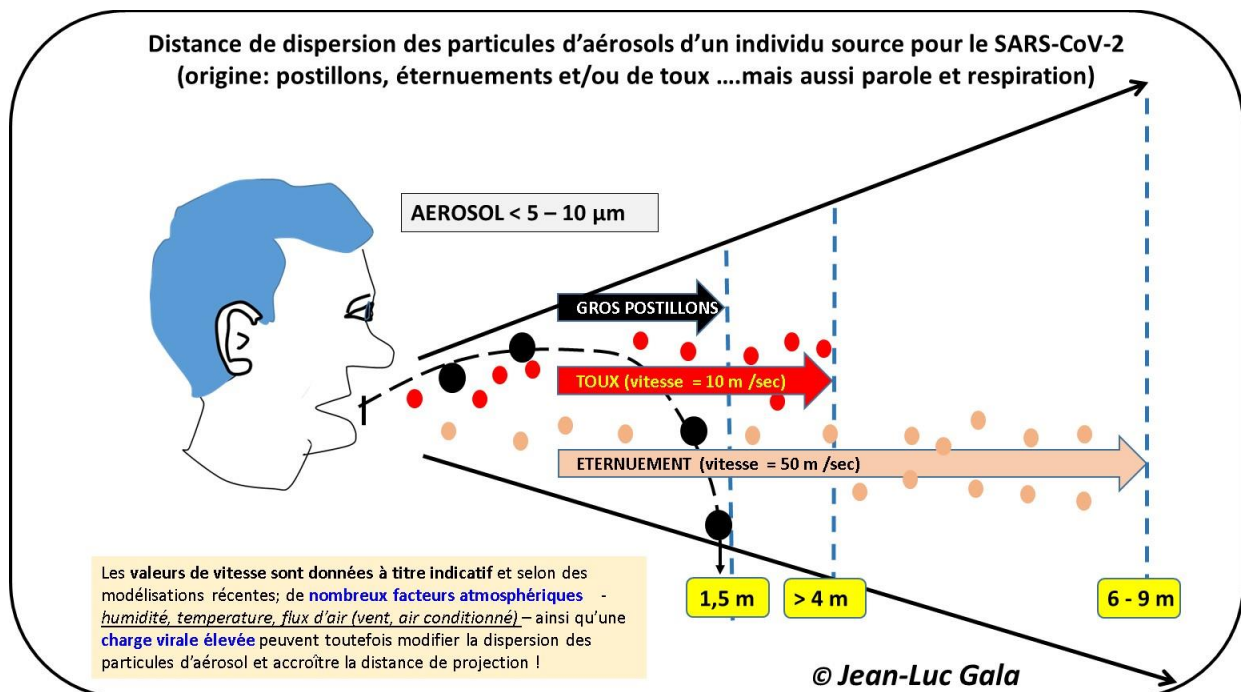
Why is the coronavirus pandemic so dangerous?

- COVID-19 virus is a coronavirus different enough from previous ones that no one is immune.
- In addition, there are two peculiarities in the mode of transmission of COVID-19 that explain such a speedy spread.
 - This virus is **transmitted mainly and very easily through the respiratory tract**, via droplets, or microdroplets and aerosols of microparticles from the upper respiratory track. Saliva droplets emitted during casual conversation range is less than two meters, that of microdroplets shed when coughing is 2 to 4 meters, but that of the cloud of virus nebulization when coughing or sneezing is 6 to 9 meters, a cloud that can persist locally for more than five minutes or can disperse the virus much further in current air flows.

(see *Modes of transmission of Coronavirus*)

- Please note that a majority of aerosols originate from droplets and microdroplets after some of their water evaporates to leave particles small enough to stay airborne. This explains why fabric masks can notably diminish aerosol production.

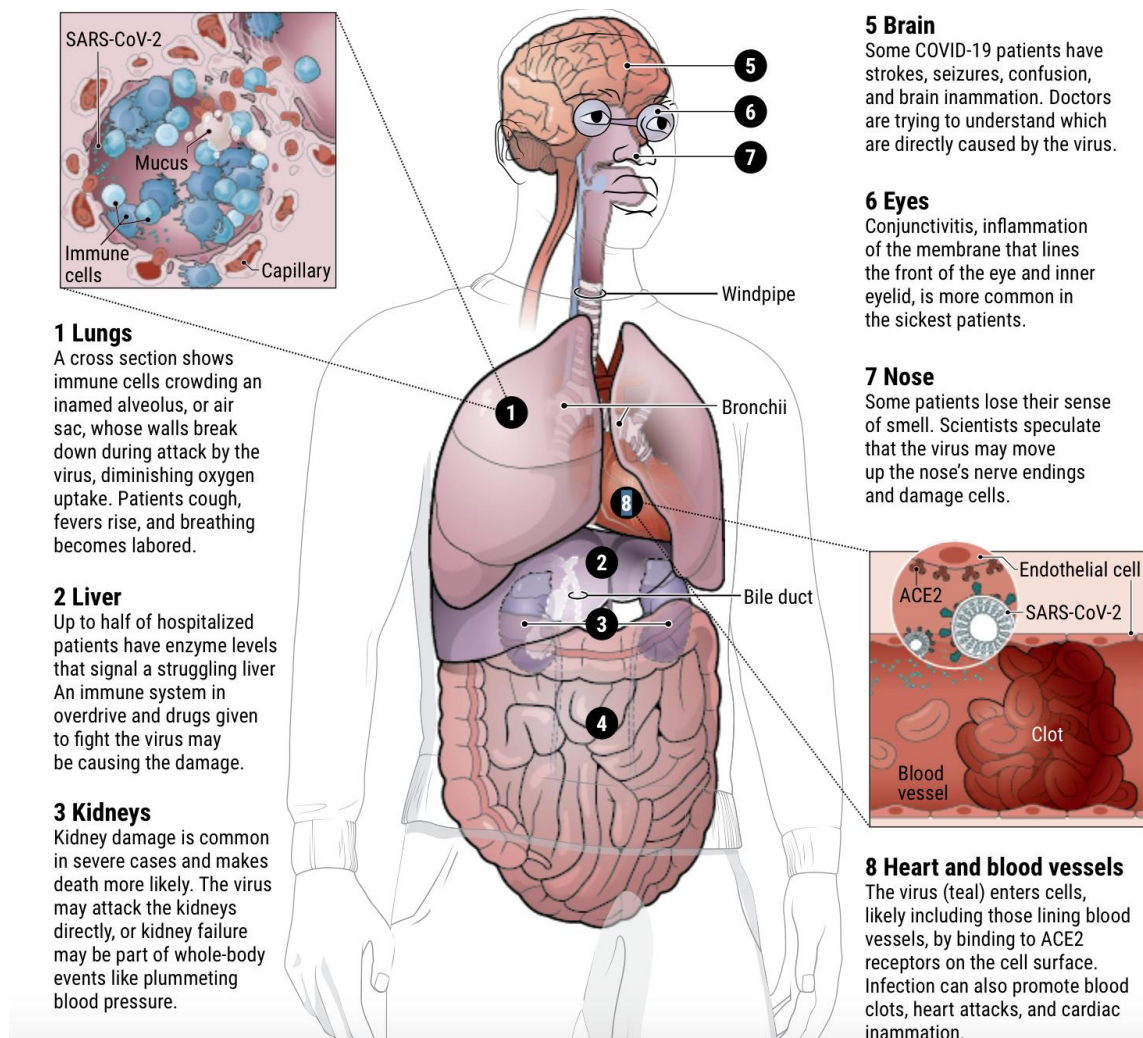
Papineni R, Rosenthal F. The size distribution of droplets in the exhaled breath of healthy human subjects. J Aerosol Med. 1997 Summer;10(2):105-116



- The majority of infected people have **no symptoms for the first few days, but are already spreading the virus**; this “*presymptomatic*” spreading window lasts a couple days on average but can last up to 15 days; it concerns half of the infected people. This is a major mode of transmission of the COVID-19 virus.
- About 30% of the infected people will not feel ill; they are called the *asymptomatic* group.

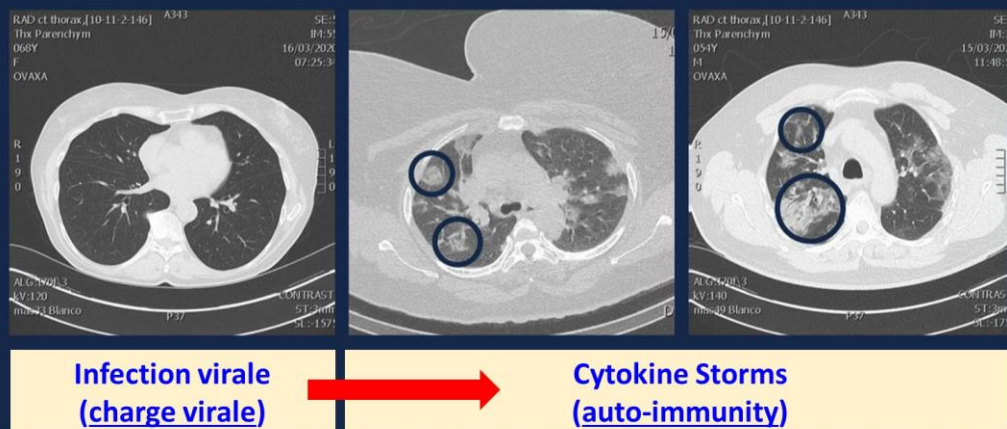
Gandhi M, Yokoe S, Havlir D. Asymptomatic Transmission, the Achilles' Heel of Current Strategies to Control Covid-1. NEJM April 24, 2020 DOI: 10.1056/NEJMe2009758

- The symptoms for this disease are most fickle and make clinical diagnosis uncertain in the **less severe, but equally contagious forms**:
 - Loss of taste and/or sense of smell
 - Intense headaches
 - Intense and sudden weakness, linked to a drop in blood pressure
 - Muscle aches
 - Diarrhea (more common in children)
 - Fever
 - Pulmonary involvement :
 - Cough
 - Shortness of breath (dyspnea)
 - Feeling of asphyxiation
 - Desaturation (blue blood)
 - CT scan with bilateral lesions with frosted glass appearance.
 - Hypercoagulation leading to emboli, heart attacks, brain damage.
 - Direct heart inflammation, with arrhythmias



Source : V. ALTOUNIAN/SCIENCE

Scanner Pulmonaire de patients COVID-19



<https://www.vrt.be/vrtnws/en/2020/03/17/lung-scans-covid-19-thirtysomethings-show-scary-picture/>

- The disease can be serious and even fatal in a significant proportion of individuals, especially but not only in the elderly. In its severe forms, Covid-19 is a multi-organ disease targeting mainly but not only blood vessels in the lungs, liver, kidneys and heart. People who are already hypertensive, have a cardiac condition and are suffering from cancer have a high mortality rate.

Guan W-jie, Liang W-hua, Zhao Y, et al. Comorbidity and its impact on 1590 patients with COVID-19-19 in China: A Nationwide Analysis. Eur Respir J. 1 April 2020; in press
(<https://doi.org/10.1183/13993003.00547-2020>).

Fei Zhou, MD † Ting Yu, MD † Ronghui Du et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19-19 in Wuhan, China: a retrospective cohort study. Lancet March 11, 2020
DOI:[https://doi.org/10.1016/S0140-6736\(20\)30566-3](https://doi.org/10.1016/S0140-6736(20)30566-3)

Murthy S, Gomersall CD, Fowler RA. Care for Critically Ill Patients With COVID-19 JAMA Published online March 11, 2020 doi:10.1001/jama.2020.3633

Arentz M ·Yim E et al. Characteristics and Outcomes of 21 Critically Ill Patients With COVID-19-19 in Washington State JAMA. Published online March 19, 2020. doi:10.1001/jama.2020.4326

- For yet unknown reasons, women are less often affected than men, and children even less so.
(Read: *Are patients of African descent at high risk of getting COVID-19?*)
(Read : *Children and Covid-19*)

Gudbjartsson DF, et al. Spread of SARS-CoV-2 in the Icelandic Population. April 14, 2020, at NEJM.org.
DOI: 10.1056/NEJMoa2006100

Jones TC, C. Drosten. An analysis of SARS-CoV-2 viral load by patient age. May 1, 2020.

- The major dangers of this pandemic lie in its consequences to :
 - Public Health : heavy tensions on the hospital structures with the potential to break down other essential programs (malaria). If low income countries insufficiently protected first line personnel may pay a heavy toll to Covid-19.
 - Society : the high mortality of high-risk people imposes lock-down policies,
 - Economy : closure of non-essential stores, major loss of income in the whole informal economy (dominant in low-income countries), bankruptcies...

Children and Covid-19

It seems that Covid-19 only rarely affects children. In China a report from the Chinese Center for Disease Control and Prevention about 72.314 Covid-19 cases, dated 26th of February, states that only 1% were less than 10 years old.

Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. JAMA. 2020 Feb 24. doi: 10.1001/jama.2020.2648. [Epub ahead of print]

In **Wuhan**, among 1,391 children tested at the children hospital 171 (12.3%) were positive for Covid-19 (PCR). The mean age was 6.7 years; 41.7% developed a fever; 27 (15.8%) never had any clinical nor radiological symptoms while 12 had radiological signs of pneumonia without any clinical infectious symptom; 3 children were admitted to the ICU and ventilated: all three had severe pre-existing conditions.

Lu X et al. SARS-CoV-2 Infection in Children March 18, 2020, at NEJM.org. DOI: 10.1056/NEJMc2005073

On the 25th of March **Italy** reported 69,176 Covid-19 cases; 1 % (692) were less than 18 years old; 76 (11%) were admitted in hospital, and none died. The study 'CONFIDENCE' followed a cohort of 100 children admitted in the emergency room and tested positive for Covid-19 (PCR) average age was 3.3 years old, among them 40 aged less than 12 months. No family source of infection could be found for 55 of the 100 children. (In Italy the lockdown was decided late and this may have reduced the relative role of family contagion). 21% of the cohort had no symptom, 58% had mild symptoms, 19% were moderately ill, 1% had severe illness, and 1% were in a critical state. For only 4%, blood oxygen < 95% was recorded and these had typical radiology images of pulmonary involvement. Nine children needed respiratory assistance (no details given); none died.

Parri N, Lenge M. Children with Covid-19 in Pediatric Emergency Departments in Italy May 1, 2020, at NEJM.org. Letter. DOI: 10.1056/NEJMc2007617

Iceland (population: 365,000) launched a large PCR testing campaign, 1)- targeting people who had contacts with Covid-19 patients and 2)- testing two control populations (one on voluntary basis, the other at random). Data confirm a relative immunity of children to Covid-19. A total absence of penetration within children among controls was a surprise.

ICELAND	Targeted tests	Tests open to the population
children < 10 y, positive (%)	38 / 564 (6,7%)	0 / 848 (0%)
All > 10 y, positive (%)	1.183 / 8.635 (13,7%)	100 / 12.232 (0,8%)

Gudbjartsson D et al. Spread of SARS-CoV-2 in the Icelandic Population. April 14, 2020, at NEJM.org. DOI: 10.1056/NEJMoa2006100.

The conclusion was that most sick children had mild symptoms only lasting 2 or 3 days, with headache and fever, while a minority developed a readily resolving pneumonia.

However, **children may harbour the virus and spread the disease** just like adults, with comparable viral loads. (TC Jones, Charité hospital, **Berlin**, Mai 2020). Such risk could only be proven the day nurseries and schools will reopen on a large scale. (TC Jones, hôpital de la Charité, Berlin, Mai 2020).

T. C. Jones et al. An analysis of SARS-CoV-2 viral load by patient age. May 1, 2020.

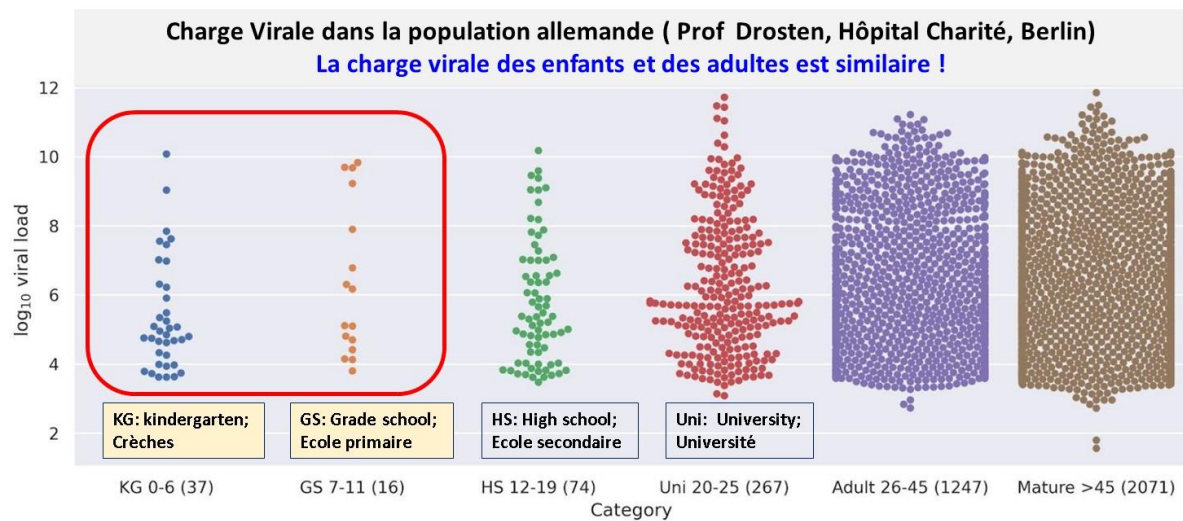


Figure : Viral load in the German population (Prof Drosten, Charité Hospital, Berlin)
The viral loads (vertical scale) of children and adults are similar, although children are less numerous .

In **Singapore**, a **6 months-old infant apparently in good health** was admitted to the hospital with his Covid-19 parents because nobody else could take care of him. The baby was tested **positive every day, with high viral loads**, and was tested negative for the first time on day 17. The sole symptom he ever developed was a temperature of 38.5°C lasting only one hour. His faeces tested positive on day 9. His mother's milk was tested on day 11, negative.

Kai-qian Kam, Chee Fu Yung, et al. A Well Infant with Coronavirus Disease 2019 (COVID-19) with High Viral Load February 2020 Clinical Infectious Diseases.

<https://academic.oup.com/cid/advance-article-abstract/doi/10.1093/cid/ciaa201/5766416>

It was concluded that children, even babies, can spread the virus. This will only be verified on a large scale when nurseries and schools reopen, mixing populations again.

A case report from Texas said that **newborns may develop severe complications** from Covid-19, that responded to conventional treatment protocols.

Coronado Muñoz A et al. Late-Onset Neonatal Sepsis in a Patient with Covid-19 April 22, 2020, at NEJM.org. DOI: 10.1056/NEJMc2010614

Covid-19 and Kawasaki syndrome in children

In **Norway** (24th of March) a 40 yo Covid-19 positive man was reported to develop haemo-phagocytic lympho-histiocytosis.

The 27th of April the PICS (Paediatric Intensive Care Society of **Great-Britain**) issued a statement in response to an email alert from NHS England highlighting a small rise in the number of cases of critically ill children presenting with an unusual clinical picture with overlapping features of Toxic Shock Syndrome and atypical Kawasaki disease with blood parameters consistent with severe Covid-19. Abdominal pain and gastrointestinal symptoms were a common feature as was cardiac inflammation. The statement quoted a case report (Jones VG) as well as the previously suggested link between severe Covid-19 and hyper-inflammation or cytokine storm syndrome, as well as macrophage activation syndrome and haemophagocytic lymphohistiocytosis. One child died in London.

Tveit K. Cytokine storms in COVID-19 cases? Tidsskr Nor Lægeforen. 2020 Mar 23;140. doi: 10.4045/tidsskr.20.0239. Print 2020 Mar 24.

Google : PICS-statement-re-novel-Kawasaki-C19-presentation-v2-27042020.pdf

Jones VG et al. COVID-19 and Kawasaki Disease: Novel Virus and Novel Case. Hosp Pediatr. 2020 Apr 7. doi: 10.1542/hpeds.2020-0123. [Epub ahead of print] PMID:32265235 DOI:10.1542/hpeds.2020-0123

The 5th of May the Complex Congenital Cardiac diseases centre of Necker hospital in Paris issued a statement about 20 Covid-19 positive children reported in **France** over less than 3 weeks with similar symptoms. « *A treatment with IV immunoglobulins seems to improve the clinical state of patients rather fast, even if several children initially needed inotropic and/or vasopressive support and even Extra-Corporeal Membrane Oxygenation* ».

<https://www.carpedemm3c.com/myocardites-vascularite-inflammatoire-et-covid-19>

The physiopathogenic link between Covid-19 and Kawasaki is still poorly understood.

Kawasaki syndrome is a very rare paediatric illness (1/8,000), following usually a common infection. It is characterised by lesions of the arteries, like the coronary arteries of the heart which then develop aneurisms (« *herniæ* ») sometimes leading to myocardial infarctions. Diagnosed early, most of the time this disease responds well to treatment.

Are patients of African descent at high risk of getting COVID-19?

- From the beginning of the epidemic in Belgium, we were struck by the unnaturally high proportion of patients of African origin showing the most severe form of the disease: these patients were occupying 15% of the resuscitation (ICU) beds in Belgium, far more than their proportion in the general population.
- In the United States nearly 70% of the casualties are African-Americans.
- Socio-economic causes or genetic cause?
- A study published in the form of a letter on April 14th 2020 by the University of Ghent (in Belgium) establishes a connection between several known facts and epidemiological data from some thirty countries.
- The rationale can be summarised as follows:
 - Coronaviruses have as entry point on the surface of target cells the antigen (and angiotensin hormone receptor) ACE, which is found in high concentrations in the nasal mucosa.
 - Several variants of this receiver exist,
 - COVID-19 has a different affinity for the various variants of ACE, with the maximum affinity for the ACE-1-D form,
 - the proportion of the population carrying the ACE-1-D allele is documented and varies from country to country, with the highest proportion in Africa and the lowest in the Far East
 - The team in Ghent matched the incidence statistics of COVID-19 in different countries with their proportion of carriers of the ACE-1-D allele and reported a strong relationship between the two.
- All this remains to be consolidated, but this does not seem to be good news for Africa, which lacks the means to effectively treat the most severe forms of the disease. This information therefore emphasizes that the strategy of preventing contagion must take precedence over therapeutic measures, as prevention is the action most likely to reduce the number of infected people. **Once again: taking actions upstream of a phenomenon is more effective and less costly.**

Delanghe D, Speeckaert M, De Buyzere M. COVID-19-19 infections are also affected by human ACE1 D-I polymorphism. Clinical Chemistry and Laboratory Medicine (CCLM) | Ahead of Publication DOI: <https://doi.org/10.1515/cclm-2020-0425> | Published online: 14 Apr 2020

Vaduganathan M, Vardeny O, et al. Renin-Angiotensin-Aldosterone System Inhibitors in Patients with COVID-19-19 N Engl J Med March 30, 2020 DOI: 10.1056/NEJMs2005760

Vibha Bhatnagar, et al Angiotensin-converting enzyme gene polymorphism predicts the time-course of blood pressure response to angiotensin converting enzyme inhibition in the AASK trial J Hypertens. 2007 October ; 25(10): 2082-2092. doi:10.1097/HJH.0b013e3282b9720e.

Zhang H, Penninger J et al. Angiotensin-converting enzyme 2 (ACE2) as a SARS-CoV-2 receptor: molecular mechanisms and potential therapeutic target Haibo Intensive Care Med (2020) 46:586-590 <https://doi.org/10.1007/s00134-020-05985-9>

What's a face mask?

A face mask is a filter worn in front of the face.

It may serve a twin function: to protect the wearer or protecting those around them.

Face Masks intended to protect the wearer

are mainly used in industry to protect the worker from toxic products or products that may settle in the lungs. They can also be worn to protect against urban pollution. Such masks must fit tightly around the face to prevent any toxic air from around the mask to get through. Of increasing protective value they are named FFP1, FFP2 and FFP3. The entire surface may be filtering, but for FFP3 they are airtight and all the inhaled air is forced through an aperture fitted with a filter more or less specific to the contaminant(s) to be removed. FFP2 and FFP3 are used in specific circumstances in medicine such as ICU. They are not the subject of this paper because they have no use in the public space.

Face Masks designed to protect a person from the air exhaled by others

in the surroundings are mainly used in medicine. In the operating room, for example, each staff member wears a so-called **surgical mask** to reduce the presence of bacteria in the ambient air. This is one of the measures to reduce the infection rate of patients undergoing surgery. These masks are not airtight but are filtering masks. It is estimated that they are capable of removing more than 99% of exhaled bacteria, the majority coming from the nose and mouth of mask bearers. The air in operating theatres is rapidly renewed (more than ten times per hour) and the number of bacteria in suspension therefore remains extremely low.



Figure : surgical mask (Photo Ph Baele)

FFP1	FFP2	FFP3
		

Figure (advertisement photos, internet) : respiratory protection masks.

What is a filter? Are there various types of filters?

- A filter is a system for trapping certain contaminants in water or air. To put it simply, there are two types.

Screen-filters:

This is a membrane the surface of which features holes smaller than the particles to be captured. They are used all over the place. Think of these small pillars fencing off roads that are forbidden to cars: the distance between each pillar is calculated to prevent cars from going through. It is the same approach that is used at all levels from factory chimneys to the membranes of heart-lung machines allowing oxygen molecules to cross into to the blood without the blood flowing out. Surgical masks are screen filters made up of a woven material so tightly woven that bacteria are retained while air passes through. The holes in the screen filters will gradually clog with trapped particles until they become completely blocked. Therefore, they have a fairly limited useful life. Their surface must be washed to make them usable again. But not all screen filters are washable. The majority of medical filters are not washable. Some are, but the fibers downgrade and the mesh loosen up: the performance decreases with the number of washes.

Depth-filters:

These are materials through which air or water will percolate and where the impurities to be removed will be retained. An example is the sand banks through which water intended for consumption passes. Other examples are the cigarette filters and HEPA filters (*High-Efficiency Particulate Air, or High-Efficiency Particulate Absorbing and High-Efficiency Particulate Arrestance*), that remove more than 99% of particles $< 0.3 \mu\text{m}$ diameter.

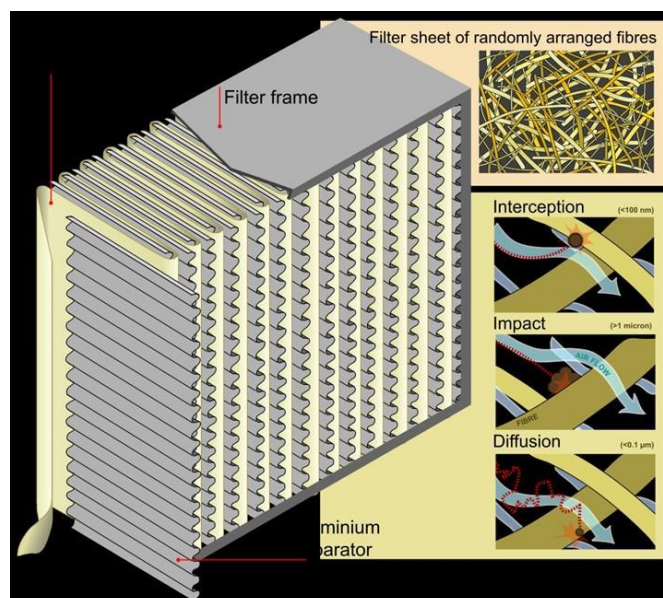


Figure : HEPA filter (source wikipedia): model showing the way particles are eliminated :
impaction, interception, brownian movement.

Basically, the material that retains the impurities is not impervious to them, but the impurities will latch on to it because the meanders imposed on the flow slow it down and the impurities, which are heavier and less fluid, accumulate within the filter. Their action could be compared to a network of very narrow streets through which traffic would have to pass to reach the other side of a city. It is easy to understand that as soon as a delivery man has to stop, a traffic jam spawns and an entire street is blocked. What happens with this type of filter is that it quickly creates preferential routes where the flow is faster and where no contaminants would be caught. They lose their effectiveness long before they become completely blocked. They must be replaced at regular intervals depending on the density of the contaminants to be trapped and the flow rate of the fluid to be purified. The filter media chosen are very specific to each use. Charcoal is frequently used because it retains many toxic substances: it is used in some individual masks for industrial workers, they are also found in gas masks. In both cases the filter cartridge must be replaced regularly.

- Some safety masks used in intensive care or in microbiology labs are depth masks whose cartridges must be replaced regularly.
- **Tests:** The same technologies are used to test pollution masks and medical masks. Medical masks are not normally tested with real bacteria or viruses, but with particles of the size of the pathogens you want to capture.

Is the surgical mask efficient for capturing a virus?

A recent study on patients revealed that surgical masks are effective in filtering flu viruses or coronaviruses, but not rhinoviruses, which also cause colds. It has also shown that some asymptomatic patients shed droplets (>5 microns) or aerosols (<5 microns airborne particles) containing viruses, including coronaviruses, and that the surgical mask does retain them.

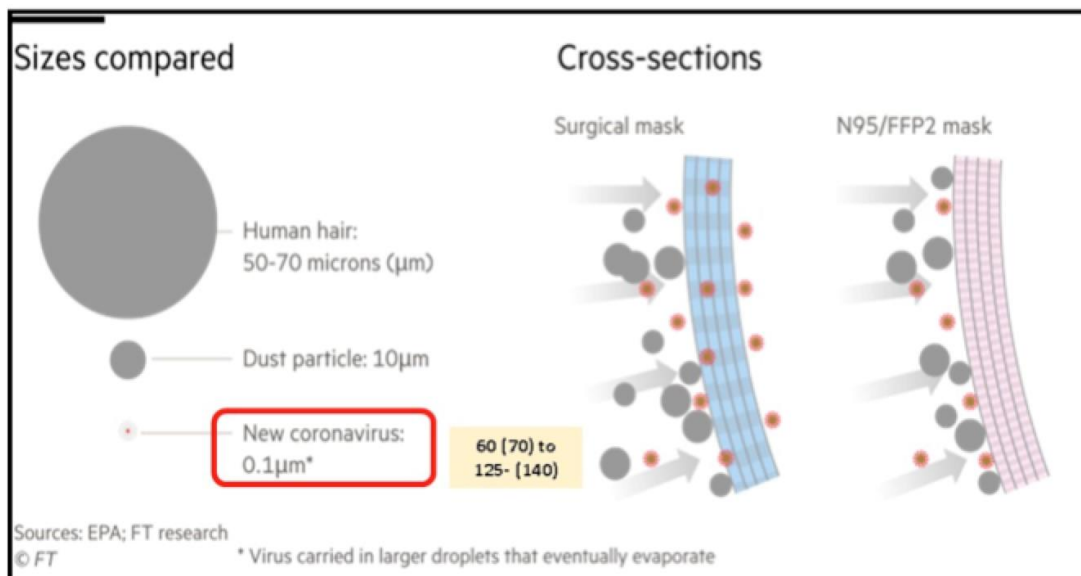
Leung, N.H.L., Chu, D.K.W., Shiu, E.Y.C. et al. Respiratory virus shedding in exhaled breath and efficacy of face masks. Nat Med(2020 3 April). <https://doi.org/10.1038/s41591-020-0843-2>

Theoretically the so-called “surgical” mask is only a mask against projections, i.e. a class 1 medical device according to the European directive 93/42/CEE

There are two sub-categories:

- Type I masks; filtering 95% of bacteria
 - Type II masks; filtering >98% of bacteria
- Type II masks are, in turn, divided into the Normal kind and the R kind, which are tighter and more resistant to projections.

In contrast with FFP2 masks (reserved for ICU and Covid-19 units) the surgical masks are not meant to provide protection against virus penetration.



The reason why surgical masks do intercept a proportion of exhaled viruses is that particles <0.3 mm do not move linearly but erratically. Therefore they no longer obey linear movement physics that define impurities-to-filter apertures.

(Read: Is a face mask made of household fabric efficient for intercepting a virus?)

Finally, surgical masks are often made electrostatic so as to attract virus proteins to better catch them.

(Read: Can a commercial mask be washed for reuse?)

Can a commercial mask be washed for reuse?

Some firms sell "washable and reusable" masks. What about them?

- After washing with soap and water and drying, there is a 21% loss in filtration efficiency. This drop is due to the loss of the electrostatic charge of the masks fibers.
- Some firms sell (washable) cotton masks with an N95 filter, the latter is not washable.
- Is it preferable to soak the mask in alcohol (70% isopropanol)? No, there is a loss of filtering efficiency of 37 to 47% for particles larger than 0.3 microns. The reason being the same as washing with soap: loss of the electrostatic properties of the mask fibers.

The answer is therefore **NO**: washing a commercial mask does not extend its useful lifespan.

<https://smartairfilters.com/en/blog/washing-masks-effective-virus/>

Is a face mask made of household fabric efficient for intercepting a virus?

Smart Air is a social enterprise based in China, India, Mongolia and the Philippines interested in controlling air pollution and its effects. It defines its mission as follows:

Smart Air is a social enterprise dedicated to helping people protect themselves from the harms of air pollution through education and cost-effective purifiers.

- SmartAir specializes in the production of air pollution filters. It has put on its website a series of pages concerning individual face masks, including analyses on the performance of fabric face masks.
 - <https://smartairfilters.com/en/blog/category/masks/>
- For those interested in the methodological details of the **tests used**:
 - <https://smartairfilters.com/data/en/raw-data/> and :
 - <https://smartairfilters.com/en/blog/what-is-pm0-3-why-important/?rel=1>
- Let us just remember that **particles smaller than 0.3 microns** do not behave like the larger ones and are paradoxically easier to capture because they move erratically (and not in a straight line, specialists call this the "Brownian motion") and because they collide more easily in the materials encountered.
- In particular, this firm has published a **comparative study of the filter materials** used to make medical masks.
<https://smartairfilters.com/en/blog/best-materials-make-diy-face-mask-virus/>
- Their conclusion: **YES, the single layer cotton mask has a non-negligible efficiency of about 50% of that of the surgical mask.** This filtering power can be further increased by various manufacturing features. Homemade fabric masks have indeed a poorer performance than surgical masks or N95/FFP2 masks. However, wearing a homemade face mask for more than 3 hours did not affect their filtration capacity. On the contrary, as it absorbs some of the breath moisture this enhances slightly the filtration capacity of homemade fabric masks. With surgical masks, on the other hand, there is a drop in effectiveness with time owing to the moisture in the breath.
- Homemade masks are also efficient with children, albeit with **8% less efficiency in children.**

Anna Davies , Katy-Anne Thompson , Karthika Giri , George Kafatos Testing the Efficacy of Homemade Masks: Would They Protect in an Influenza Pandemic? Disaster Med Public Health Preparedness. 2013;0:1-6 Volume 7, Issue 4 , pp. 413-418

van der Sande M, Teunis P, Sabel R. Professional and Home-Made Face Masks Reduce Exposure to Respiratory Infections among the General Population. PLoS ONE 2008; 3(7): e2618.

Are all materials equally good to make DIY fabric face masks ?

- **NO**, some have a better filtering factor than others.
- But comfort should be reckoned with : a face mask giving little comfort, is more likely to be worn improperly or too rarely.
- To compare the filtering power of materials: see <https://smartairfilters.com/en/blog/best-materials-make-diy-face-mask-virus/>
- To compare the other respective qualities of the materials: read the opinion of a textile engineer who is also a dressmaker blogger: <https://coutureetpaillettes.com/mes-coutures/masques-tissus-prevention-coronavirus/>

The two fibres most used by industry are cotton and polyester.

COTTON		POLYESTER	
Positive aspects	Negative aspects	Positive aspects	Negative aspects
- natural fiber - flexible fiber - breathable fiber - High temperature washable without loss of properties - little prone to maceration	- hydrophilic: absorbs up to 20% water - Mild humidification improves by 5% its capacity to intercept particles <0.3 µ after 3 hours and improves immediately its capacity to stop micro-droplets generated by speech.	- hydrophobic: does not absorb moisture - electrifies easily (thus attracting particles) - good rubbing resistance	- man-made fiber - rough touch - loss of its textile properties above 30/40°C (deforms and wrinkles) - Cannot be washed at 60°C

Sources of the table : completed and modified from :

- <https://coutureetpaillettes.com/mes-coutures/masques-tissus-prevention-coronavirus/>
- <https://smartairfilters.com/en/blog/diy-home-made-mask-protect-virus-coronavirus/?rel=1>
- Anfinrud P, Stadnytskyi V. Visualizing Speech-Generated Oral Fluid Droplets with Laser Light Scattering (Letter) N Engl J Med April 15 2020 DOI: 10.1056/NEJMc2007800

- There is more than just filtering power: that polyester has a better filtering power but is also a **better carrier for bacteria** is acknowledged. This is significant in tropical environment. Housewives all know that underwear containing polyester is more prone to body odour than cotton, a sign of bacterial proliferation. Yet the mouth is full of bacteria that comes with our breath...
- **Avoid** "treated" cottons: wax, plasticized or oiled...
- **Avoid** loose cotton as well: lace, English embroidery, double cotton gauze...
- In practice, **two different cotton fabrics are preferred**: one, woven more tightly, for the external face of the mask, the other for the internal face. One of the objectives is to guarantee... that there will be at least one fairly more tightly woven fabric than the other one, so as to generate a more turbulent flow when passing from one layer to the other, which leads to greater erratic movement of the particles <0.3 microns and therefore a better chance of capturing them.
 - A single layer of tightly woven cotton already intercepts ~80% of particules <0,3 microns if the mask is well fitted, i.e. better than a surgical mask according to Konda. Ideally an

electrostatic filter will be added behind the strong cotton layer, in order to intercept up to 95% of <0,3 microns particles. All these values plummet with ill-fitted masks of any kind.

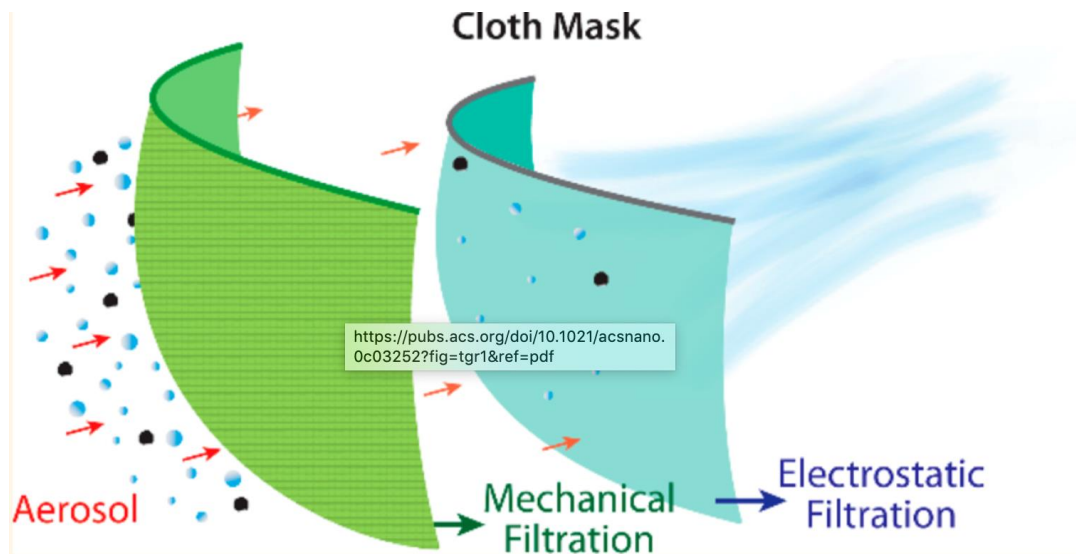


Figure : cfr reference Konda.

- Konda A, et al Aerosol Filtration Efficiency of Common Fabrics Used in Respiratory Cloth Masks *ACS Nano* April 24, 2020, DOI: 10.1021/acsnano.0c03252

- Therefore it is suggested to put an electrostatic filter inside the pouch of the citizen mask because such filters
 - Do not tolerate being washed at 60°C and
 - Loose their electrostatic properties after being washed.

Those single-use filters inserted inside the pouch may be removed after use in order to wash the citizen mask. A new filter will only be inserted in a clean and dry mask.

Does kitchen paper have a filtering capacity?

- **YES**, but low: a single layer of kitchen paper stops 23% of 0.3 micron particles.
- Adding a second layer stops 33% of these particles.
- "Better than nothing," the authors conclude.
- It is possible to add one or two layers of kitchen paper in masks made of two layers of cotton sewn into an envelope:
- Against COVID-19: <https://www.opensourceagainstcovid19.org/fr/>
- <https://smartairfilters.com/en/blog/paper-towel-effective-against-viruses-diy-mask/>

Are there any arguments other than the filtering power of masks to favour their widespread use in the event of an outbreak of respiratory viruses?

- Wearing a face mask restricts the often unconscious gestures which make us touch our mouth or face with our hands.
- Wearing a face mask is obvious for all to see... just like the nose in the middle of the face! It is therefore **easier to monitor** than other protective measures: confinement, physical distance between individuals, frequent hand washing.
- Wearing a face mask is a **visible and permanent reminder of the very existence of a danger** that is invisible.
- Wearing a face mask **makes everyone feel responsible** creating the feeling that everyone can become an actor in a fight rather than passively undergoing an event that is out of one's control. This is an important argument for the authorities, who have a clear advantage in taking the lead with this measure.
- It is better **to convince**. An obligation is often felt as an externally imposed constraint and triggers resistance.
- Wearing a face mask on a large scale puts everyone in the same boat: potentially creating a feeling of **solidarity** among the population towards the **ordeal everyone is going through**.
- **Finally, the fabric homemade face mask can build up the national strategic reserve that can be mobilised in less than 24 hours!** As in the Far East, if the population puts on the mask at the slightest epidemical alert of a respiratory-transmitted pathogen, a first barrier to the spread of the disease is immediately erected. The BBC Pandemic experiment ([see this theme et the end of document](#)) has shown how crucial the first 72 hours are in containing an epidemic.

What's the point of wearing a face mask in public or at work?

- The primary purpose of masks is **to protect others**: that's the reason for wearing them in the operating room.
- However, the face mask **also protects the wearer**
(read: Is there any scientific evidence that the mask could be useful?)
- An important concept is that of **MUTUAL PROTECTION**: the aim is not to protect the individual as such, but to curb the spread of a respiratory-transmitted virus by reducing its aerosolisation from the wearer and reducing its inhalation by potential recipients. Both are equally important, but the prior has more impact as acting upstream is always more efficient. A single disseminator could very well infect several people.
- If you and somebody coming along in a store both wear a mask, and let us suppose that person is 'infected', your mask and that person's will considerably diminish your risk to be contaminated... But if you are the infected one then the other person will be protected. Mutual protection considerably reduces virus spread in the community.
- The truth is : neither you nor the person facing you know who carries the virus!
- This epidemic has brought out the notion of "**MOBILE INDIVIDUAL CONFINEMENT** " (Newspaper *Le Monde*): wearing a face mask is like wearing the home where one is confined, somewhat like the turtle protects itself by wearing its own shell!

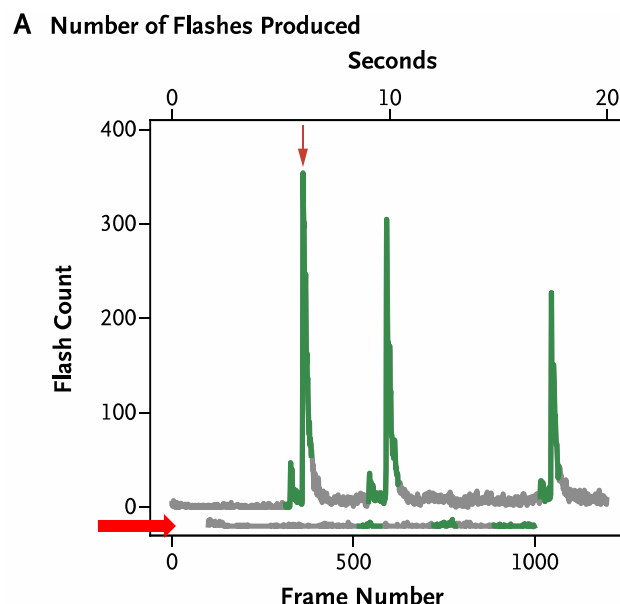
Newspaper *Le Monde*, Published on Sunday, March 22, 2020 at 10:06 a.m. Letter from Florence de Changy, Hong Kong correspondent for Le Monde, RFI and Radio France, to Martin Hirsch, Director of Assistance Publique-Hôpitaux de Paris. From Hong Kong: "I am stunned to hear authorities continuing to claim that a face mask is next to useless ".

- Hence the fact that some governments are using that very concept to advocate the use of face masks when phasing out lockdown. Better late than never...

Does a face mask decrease the release of micro-droplets of saliva when speaking?

YES :

- The upper line in the Figure illustrates the number of drops and microdroplets emitted when the same sentence ("*Stay Healthy*") is pronounced three times, less and less loudly. Each peak corresponds to one sentence. It shows the quantity released is higher when the tone is louder. In another paper the same team computed the number of virus-laden droplets are emitted that end up as aerosol every minute of a conversation.
- The lower trace (big red arrow) was recorded under the same conditions while the speaker was wearing a **single** layer of slightly **damp cloth** in front of his mouth: almost no microdroplets emitted.



- Anfinrud P, Stadnytskyi V. Visualizing Speech-Generated Oral Fluid Droplets with Laser Light Scattering (Letter) N Engl J Med April 15 2020 DOI: 10.1056/NEJMc2007800

- Stadnytskyi V, Bax C, Bax A, Anfinrud Ph. The airborne lifetime of small speech droplets and their potential importance in SARS-CoV-2 transmission PNAS: May 13, 2020 <https://doi.org/10.1073/pnas.2006874117>

- In reply to this publication, it was recalled that breathing and speaking also generate aerosols of much smaller particles that can penetrate deeper into the lungs, as far as the alveoli. The COVID-19 virus can remain infectious in these aerosols for several hours. This underscores the importance of wearing a mask during a conversation.

- Meselson M. Droplets and Aerosols in the Transmission of SARS-CoV-2 N Engl J Med April 17 2020 DOI: 10.1056/NEJMc2009324

What about protective visors ?

- **In medicine, a protective visor is never worn alone** : it only deflects or intercepts saliva droplets coming from a patient undergoing a manoeuvre that makes him cough, sneeze or spit : a deep nasal swab for Covid-19 diagnosis, inserting or removing an endotracheal tube, respiratory therapy, bronchial aspiration... One of the objectives is to protect the eyes of the operator because the virus can penetrate the conjunctiva, a rare mode of disease transmission. Wearing protective goggles achieves the same result.
- **A visor is not airtight.** At inspiration the air flux comes from the sides of the visor, and it will go the same way back at expiration. Each respiratory cycle yields rapid air flows from the outside to the lungs via the airways and back out from the lungs through mouth and nose.
- **Aerosols follow these respiration airflows along the sides of the visor.** As far as the Covid-19 virus is concerned, a visor provides no protection at all against aerosols neither to its wearer nor to the people he/she may be facing. (*Read : Modes of transmission of coronavirus*).
- **A visor does not absorb anything** : as soon as it is soiled, its surface must be cleaned with a virucidal solution, according to a standard operating procedure. Decontaminating its parts is more complex than cleaning a cotton mask. One may not sterilise a visor in a standard hospital autoclave that works at 100°C.
- **A visor has no filtering capacity : it is worn IN ADDITION TO A MASK.** The mask is needed to intercept small size particles (like viruses) when inspired or expired air passes through the depth of its fabrics. (*Read : What is a filter? Are there various types of filters?*)
- **Wearing a visor alone only makes sense for jobs where the worker must be protected from direct (= straight line) projections** of relatively big particles. Those visors are then adapted to the type of materials they must intercept.
- **Visors are a complementary mode of protection.** They are costly and can therefore not be distributed on a large scale, especially in low-income countries.



Photos Ernest Ahounou & Françoise Legros

Is it possible to prove scientifically that the general wearing of the face mask is HELPFUL? And is it possible to scientifically prove that the general use of the mask is UNHELPFULL?

- The answer is **NO**, to both questions! This is the answer given by a microbiologist specialized in this field: Alan Burch, University of Berkeley, interviewed on the evening of April 1st by James Griffiths, CNN.
- Consult also : <https://www.cochranelibrary.com/cca/doi/10.1002/cca.2965/full>

Why is it impossible to scientifically prove the usefulness and uselessness of wearing a face mask in public?

- Ideally, to meet the criteria of "evidence-based medicine", a prospective randomized study with a control group would be required, with a masked group and an unmasked group being numerically equal. For obvious reasons a so-called "double-blind" study is impossible, the very principle of these studies being that neither the patient nor the doctor knows who is receiving conventional treatment and who is receiving the new treatment: it is obviously impossible not to know who is wearing a face mask!

There is, however, a German prospective study comparing three series of households in which there was a case of seasonal flu, randomly allocated to three different strategies: wearing a face mask, wearing a face mask together with hand washing, and no specific instructions. The first two groups experienced significant less flu transmission.

An Australian prospective study came to the same conclusion regarding the transmission of various forms of influenza, despite low compliance to face mask use in the study population.

However, these situations are not comparable to an epidemic nor to the general wearing of face masks in a population.

Suess, T. The role of facemasks and hand hygiene in the prevention of influenza transmission in households: results from a cluster randomised trial; Berlin, Germany, 2009-2011. BMC Infect. Dis. 2012 Jan 26; 12:26, <http://dx.doi.org/10.1186/1471-2334-12-26> [publishedOnlineFirst:2012/01/28]

MacIntyre CR et al: Face mask use and control of respiratory virus transmission in households. Emerg Infect Dis 2009, 15(2):233-241.

- From an ethical standpoint, considering banning the use of masks in one city and making it mandatory in another city of similar size but sufficiently remote poses obvious problems, though this would be the only way to measure the efficiency of this measure in real life conditions, all other things being equal.
- In practice, also, such a study is impossible because:
 - whole populations are already accustomed to the general wearing of face masks and wear them:
 - as soon as the individual experiences the slightest respiratory symptom: runny nose, sore throat, slight cough...
 - as soon as some information or rumors of an outbreak circulate.It is therefore impossible in these countries to set up a control group.
 - the other populations (Europe, North America) are not accustomed to the general use of face masks and the mutual protection effect could therefore never be achieved.

Is there any scientific evidence to say that the general use of face masks could be useful?

YES:

- Cochrane ² : Meta-analysis ³ by Jefferson et al. based primarily on studies of healthcare professionals or relatives of SARS patients. In the latter category, people who spontaneously wore a face mask when visiting their relative in hospital were much less likely to have been infected (Lau). The meta-analysis also concludes that wearing a face mask in the presence of infected patients is useful.

Jefferson T. Physical interventions to interrupt or reduce the spread of respiratory viruses: systematic review BMJ. 2009 Sep 21;339:b3675. doi: 10.1136/bmj.b3675.

Lau JT Probable secondary infections in households of SARS patients in Hong Kong. Emerg Infect Dis. 2004 Feb;10(2):235-43.

- Wu: Probably the best study to infer that in an un-informed population, wearing face masks confers protection against coronavirus transmission.

Summary of Wu's study: 94 patients with SARS during the 2002 outbreak in Beijing for whom no infectious contact could be ascertained were compared to a control group of 281 healthy people selected so that for each patient there were three people of the same neighbourhood, age and sex. For each participant, a profile of their habits was established by personal interview (for patients) or telephone interview (control group). It was found that the two groups differed significantly in the following respects: patients showed more co-morbidities (and had been seen in consultation more frequently in the weeks preceding their illness), ate more often in restaurants and took taxis more often. They were also much more likely (46%) never to wear a face mask outside the home, while many healthy people (43%) said they always wore a face mask outside the home; this difference was highly significant. (It is impossible to know whether it is the actual face mask itself that is responsible for this difference or whether it is the social habits associated with it: face mask wearers are less likely to engage or socialise in places full of non-wearers). The authors conclude that the findings (i.e., that face mask use in public reduced the risk of developing SARS) comforted the strategy of face mask use in public.

Wu J1 et al. Risk factors for SARS among persons without known contact with SARS patients, Beijing, China. Emerg Infect Dis. 2004 Feb;10(2):210-6.

² The Cochrane group is an independent non-profit organisation comprising more than 28,000 voluntary scientists from more than 100 countries ; it was created to organise in a systematic way existing information from medical research into scientific proofs useful to take medical decisions, based on well performed clinical trials (Source Wikipedia).

³ A meta-analysis is systematic scientific method used to combine results from a series of unrelated studies about a given problem, following a reproducible protocol. It allows a more precise analysis of data by pooling data to increase the number of studied cases so as to get better global conclusions (Source Wikipedia).

How do countries where the wearing of face masks is part of the culture compare to others?

5 avril 2020

	 Hong-Kong	 Vietnam	 Taiwan	 Italie	 Canada	 France
Nombre de cas	914	241	373	128 950	13 900	69 610
Nombre de morts	4	0	5	15 890	231	8 060
Habitants Millions	7,46	96,2	23,7	60,36	37,6	66,52
Densité habitants/km ²	6 357	160	656	200	3,80	117
	Port du masque à l'extérieur en tout temps (Quel que soit le type de masque...)			Les masques ne protègent pas...		

Sources au 5 avril 2020 OMS Covid-19 Maps and Jonhs Hopkins Covid-19 Maps

Le Monde

International - Coronavirus and Covid-10 Pandemic

Disparaging face mask in Europe causes dismay in Asia

By Brice Pedroletti - Published on 21 March 2020 at 08h00 - Updated March 22^d 2020 at 05h14

Wearing of face masks preventively has been instrumental in controlling contamination in developed countries of the Far East, where the call not to wear face masks in France if one is not ill is seen as a serious mistake.

Ambulatory lockdown In France, as in the rest of the Old Continent, this prophylactic chain is largely in-comprehensive, at least as seen from Asia. Thus the preventive wearing of face masks, which is none other than an **ambulant and individual mode of confinement** is widely present in the armamentarium of the region.



Picture taken in Taiwan : Spot the odd one out !

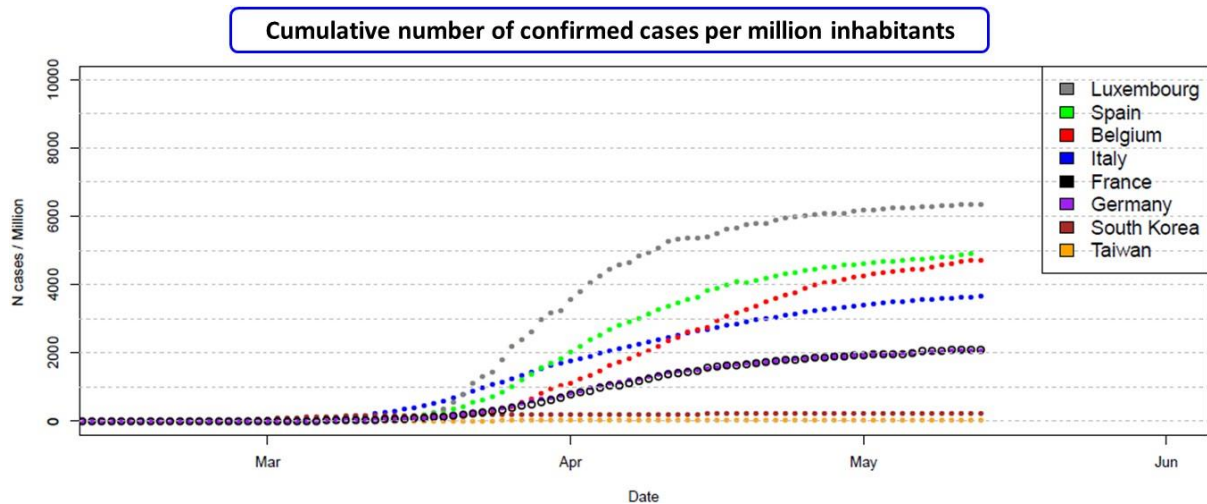


Chart from prof Gala Uclouvain

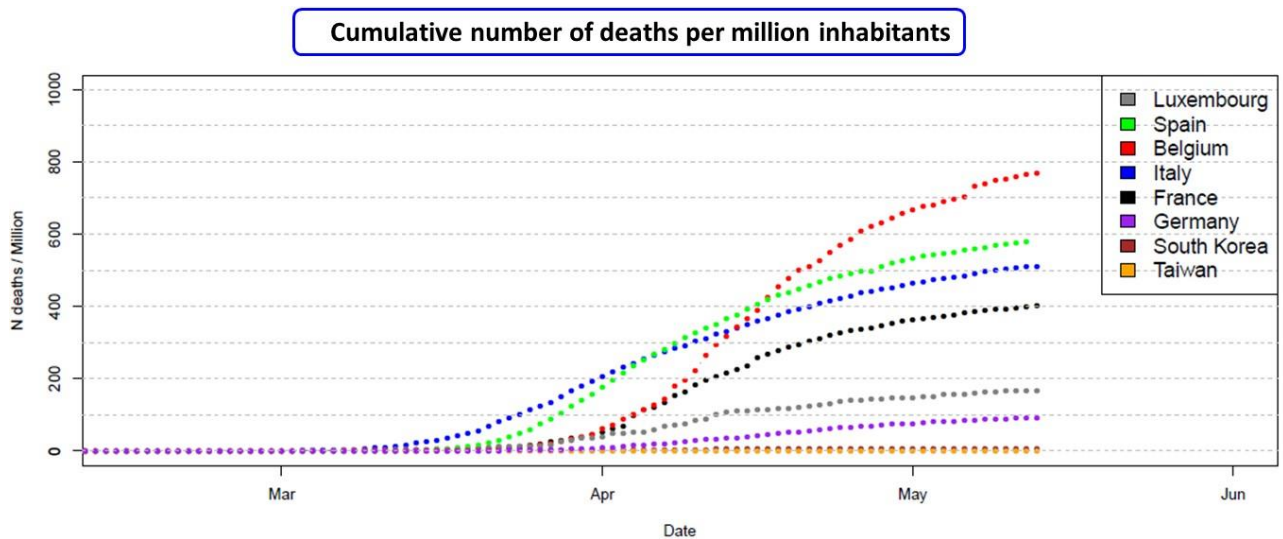
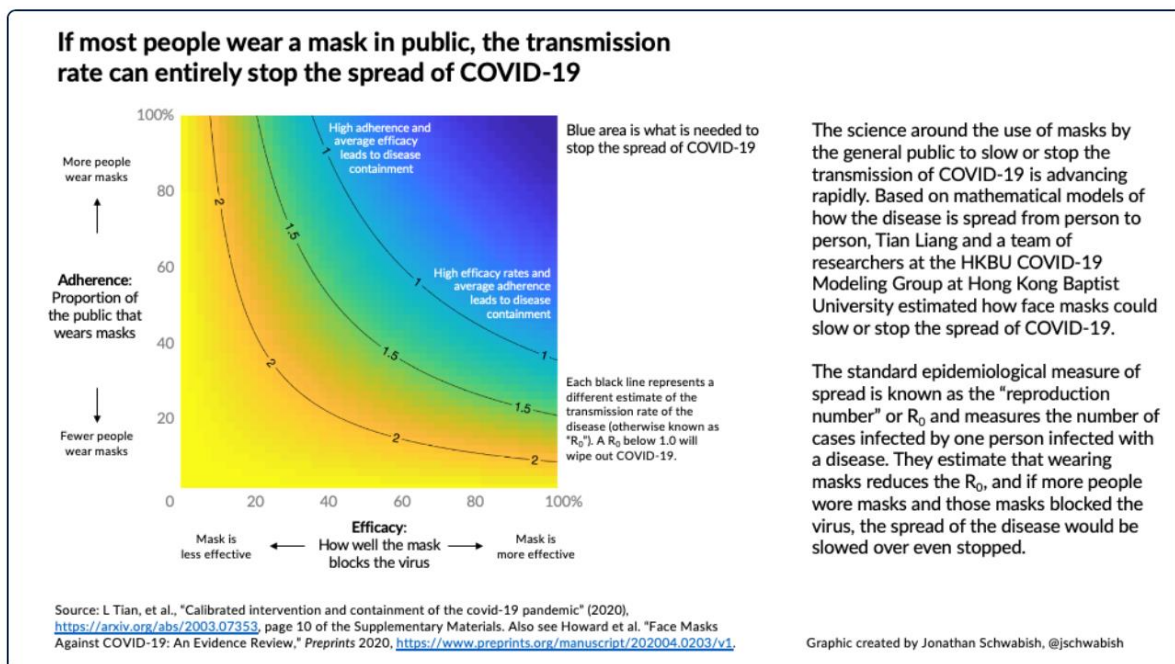


Chart from prof Gala Uclouvain

Is it possible to quantify the effect of face masks being worn by a population ?

- **YES**, despite all existing uncertainties about the quality and filtration power of hand-made masks, and about population compliance, models have been developed to calculate the effect of wearing them in the public space.



Modelled impact of mask use on reproduction rate

This kind of graph relates mask efficacy and population adherence to give R_0 , the number of people contaminated by each infected individual. The R_0 of Covid-19, without any preventive measure, is 2.4. It is possible to see from the graph that scores of 60% for adherence and efficacy already bring R_0 below 1, i.e. bring the epidemic to a standstill.

Even if only half the population wore masks with 50% efficacy, which would « only » bring R_0 to 1.35 : starting with 100 cases, after one month, the total infected individuals would be 584, instead of 31,280 without masks !

Ferguson N et al., Impact of non-pharmaceutical interventions (npis) to reduce covid19 mortality and healthcare demand. Imperial College Response Team Report 9: 16 March 2020 DOI: <https://doi.org/10.25561/77482>

Why then is it said that there is no evidence of the usefulness of widespread use of face masks?

- Cochrane: Meta-analysis by Saunders-Hastings et al: based on seasonal influenza studies: the effectiveness of mask use straddles the equipoise line (equality of probability), but there is a trend towards effectiveness. Not sufficient, however, to infer conclusively. The authors noted that their conclusions may not apply to coronaviruses that have different transmission characteristics than seasonal influenza viruses.

Saunders-Hastings P. Effectiveness of personal protective measures in reducing pandemic influenza transmission: A systematic review and meta-analysis. *Epidemics*. 2017 Sep;20:1-20. doi: 10.1016/j.epidem.2017.04.003.

- The most frequent arguments **against** the generalized use of face masks are :
 - **Fear** that the public would wear the mask improperly and it would then become a vector for a virus rather than a barrier.
 - **Fear** that the public will no longer respect social distancing.
 - **Fear** that the public will neglect other measures such as handwashing.
 - **Fear** that the public will rush to chemists and pharmacists and demand surgical masks, which is impossible to meet

(Read: why not give surgical masks to the whole population?)

- The fear arguments sound like the so-called “**Risk Compensation Theory**” which claims that any advance in safety rules encourages risk-taking attitudes counterbalancing its effects. This theory has been invoked against bikers’ helmets, car safety belts and condoms. For example it claimed that the use of condoms would encourage dangerous sexual behavior. This theory has eventually been proven false. In each instance the new rules favored safer attitudes towards previous rules, not the reverse.

- Cassell MM, Halperin DT, Shelton JD, Stanton D. Risk compensation: the Achilles' heel of innovations in HIV prevention? *BMJ*. 2006 Mar 11;332(7541):605-7.

- B Pless, Risk compensation: Revisited and rebutted. *Safety* 2, 16 (2016).

- Howard J et al. Face Masks Against COVID-19: An Evidence Review. Preprints 2020, 2020040203 doi:10.20944/preprints202004.0203.v1

- In short, **this is a top down rather than bottom-up approach**; a management mode imposed from the authorities rather than being based on public responsibility, after transparent information.
- Finally, there is some bias in the official position of a number of countries and financially dependent organizations. These positions often differ from those of independent experts.

Brousseau L, Sielsema M. Center of Infectious Diseases Research and Policy: commentary: Masks-for-all for COVID-19-19 not based on sound data. cidrap.umn.edu/news-perspective/2020/04/commentary-masks-all-COVID-19-19-not-based-sound-data April 01, 2020

- The position according which a precautionary measure should not being taken because it has never been proven to be effective sometimes runs up against common sense. People put firewalls in front of the fireplace, commandos put on parachutes before jumping out of airplanes... One wonders what scientific studies prove the usefulness of these measures.

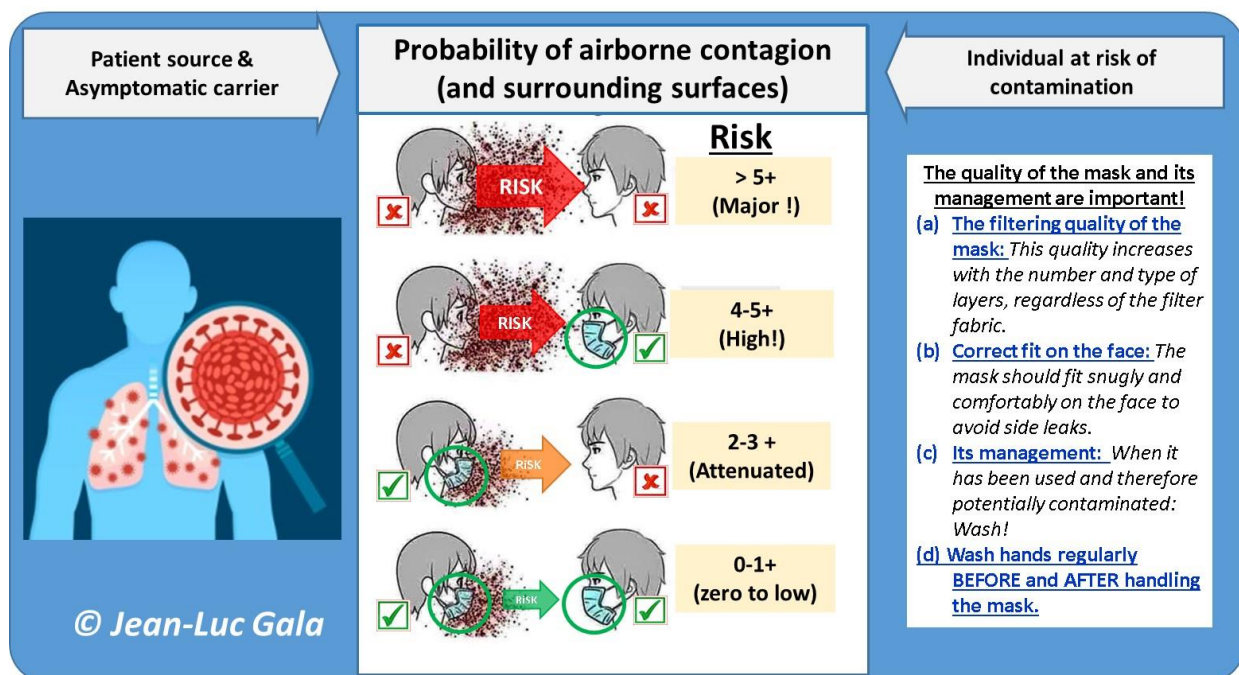
Why not give surgical masks to the entire population?

- This would seem logical since surgical masks are more effective and cheaper than homemade fabric masks?
- But the surgical mask is a single-use mask and only designed to be efficient for about 6 hours. In addition, it loses its efficiency when it becomes wet. It cannot be worn two days in a row. It cannot be washed.
<https://smartairfilters.com/en/blog/diy-homemade-mask-protect-virus-coronavirus/>
<https://smartairfilters.com/en/blog/washing-masks-effective-virus/>
- **The math is straightforward:** at a rate of one mask per day, 1 million surgical masks per million people would have to be distributed every day, 7 million per week, or 30.4 million per month. Add to this the fact that people who have to wear them at work should receive two masks and not just one, and the result would be a consumption of almost half a billion surgical masks per month for a small country like Belgium (11 million inhabitants). This proposal is obviously not realistic.
- Surgical masks are costly: the monthly expenditure for a family of four adds up to 96 €, compared with 12 € for reusable cotton masks. (Le Monde, French newspaper)
- Surgical masks are not made of paper, but from non-woven oil-derivatives : polypropylene, polystyrene, polyethylene, polyester... All those low-density and water-resistant « plastics » have a extremely long half-lives in the environment. This epidemic has already brought them on Asian beaches after being washed away by the rain to rivers and oceans. « *According to the [WHO's health guidelines](#), soiled tissues and used face masks must be thrown only into lidded litter bins, while any medical gear used by affected patients and hospital staff must be sterilised and burnt at high temperatures in dedicated incinerators. [As such, only state-of-the-art incinerators operating at 850-1100°C, with special gas-cleaning equipment, can burn these items in accordance with international emission standards.](#) Unfortunately, however, not all regions have the capacity to properly deal with the sudden spike in clinical waste generated as a result of the COVID-19 outbreak » (Earth Org). They cannot be buried in landfills. With their very short useful life and the need to replace them every day the involved quantities of plastic are enormous and the **environmental consequences** are important. Cotton masks have a much smaller ecological footprint.

- <https://earth.org/covid-19-unmasking-the-environmental-impact/>
- Le Monde, 12 mai 2020. Béatrice Gurrey. Masques : l'occasion manquée pour le monde d'après.*
- Last but not least the surgical mask, with its limited time value, does not allow to build a **national strategical reserve** that could be mobilised in less than 24 hours and used for several weeks by the entire population.

What is MUTUAL PROTECTION and why should the mask be worn widely?

- The **bilateral protection** can be demonstrated by a **very simple calculation**:
- Let's assume that the face masks in question are simply hand-made double-layers cotton face masks with a filtration capacity of barely 50% of the viruses exhaled by the wearer (a pessimistic estimate).
- If the person is infected and unknowingly spreads the virus but wears a face mask and the other person also wears a face mask, the viral load to which the latter is exposed is 50% of 50%, or 25% of the viral load he or she would have received if neither person had worn a mask. Let us repeat the same exercise with masks that are 75% effective: the residual exposure is then 25% of 25% = only 6%.
- **It is possible to significantly increase the filtering power of hand-made masks** by slipping one or two sheets of kitchen paper, coffee filters or other commercial filters into them
(*Read: Adding a filter to the hand-made mask*).
- However, **no one knows whether he or she is an asymptomatic or pre-symptomatic carrier of the virus.**
(*Read: Why is this coronavirus pandemic so dangerous?*)



(Source: Pr. JL Gala & Mr. A Delvaux . **Comment on this figure:** Wearing a face mask drastically reduces the risk of spreading due to incidental contact between an "infected individual (asymptomatic source-bearing patient)" and his or her uninfected counterpart.



No face mask: Bad attitude!



Wearing a face mask: Good attitude!

How to make a homemade face mask?

A template and a tutorial are provided in the appendix.

There are others, but you should avoid all designs with sagittal stitching, i.e. passing in front of the nose or mouth.

The ANSM (The French National Medicines Safety Agency) outlawed the use of masks with sagittal stitching (=stitching in front of the nose, mouth and chin).

Adding a filter to the homemade face mask

Kitchen paper , paper towels, " Sopalin " or " Torq " paper

- These filters are available in supermarkets, DIY stores and drugstores .
- Take sheets from a roll of paper towels or Torq paper and cut or fold them to pocket size for proper insertion and complete coverage inside the mask.



Figure: Sheets to be cut or folded from rolls of paper towels or Torq paper, folded hand towels, paper towel rolls; Photos: internet sources



Figure: Inserting sheets of paper towels into a homemade face mask. Excess paper to be cut off.



Coffee filters. (photo: internet)

Vacuum cleaners HEPA (High Efficiency Particulate Air) bags, such as HEPA 13 or HEPA 14 which are the most efficient, but seldom available in Africa

There are various HEPA filter categories depending on the effectiveness (as defined under standard NF EN 1822)

FILTRE	CLASSE	EFFICACITE (pouvoir filtrant - %)
HEPA (Norme NF EN 1822)	HEPA 10 (H10)	85
	HEPA 11 (H11)	95
	HEPA 12 (H12)	99.5
	HEPA 13 (H13)	99.95
	HEPA 14 (H14)	99.995

Ex : The H13 filter will capture 99.5% minimum of all particles ≤ 0.3 micron.

And in practice, how do you use a vacuum cleaner bag?

- Cut the bag into several squares or fold it to the size of the pocket to allow for proper insertion by covering / filling the inside of the fabric mask pocket as completely as possible.

Other filter possibilities:

There are no limits to creativity, but the filters used must not hamper comfortable breathing!

- **Nappies in textile** (in grouse) are also a good absorbent and filtering material that can be cut to size. (washable).
- **Duffel fabric**: Soft, warm, fluffy, lightly spun woollen fabric, resembling thick flannel. (washable).
- **Dry "Swiffer" wipes**: electrostatic, they trap small particles.

Impregnation of the filter by salt crystals inactivates the virus (Quan 2017 ; Neupane, 2020).

Quan, F. S., Rubino, I., Lee, S. H., Koch, B., & Choi, H. J. (2017). Universal and reusable virus deactivation system for respiratory protection. *Scientific reports*, 7(1), 1-10.

Neupane, B., & Giri, B. (2020). Current understanding on the Effectiveness of Face Masks and Respirators to Prevent the Spread of Respiratory Viruses.

Not suitable :

- Wadding, fleece, sponge, felt, minky, PUL...
- Sanitary towels : NO for 2 reasons :
 - there is a waterproof part that makes breathing difficult,
 - they contain chemicals that are not good to breathe and may be allergenic.

The filters are single-use

They are to be removed from the mask before washing it. Filters should only be put back in a clean, dry mask. Exceptions: fabric filters are washable, but must be washed separately from the mask.

Does a face mask worn in public also protect the wearer?

- **YES.** Contrary to a widely spread popular belief, there is at least one study showing that wearing a mask also protects the wearer.

Wu J1 et al. Risk factors for SARS among persons without known contact with SARS patients, Beijing, China. Emerg Infect Dis. 2004 Feb;10(2):210-6.

(Read a summary of this study in [Is there any scientific evidence that the mask could be useful?](#))

It is said that a badly worn face mask is more harmful than no mask at all...

- It is true that some mistakes can offset the positive effects of wearing a mask, or can even turn it into a vector for contamination.
- But it only takes a minute to teach a trainee (nurse, doctor, physiotherapist...)

The basic rules for wearing a mask:

- The basic rule is that the outside of the mask must remain clean.
- The inside of the mask is considered dirty.
- Initially the mask is considered clean, but not sterile:
 - It is placed on the face without touching the front part with the hands.
 - You put it on your mouth AND nose
 - Do not touch the front of the face mask once it is put on (hands would contaminate it).
- The surgeon does not brush his hands until the mask is put on. Once his hands are considered sterile, he puts on the surgical protective suit and finally puts on his sterile gloves.
- Once fitted, the mask - not sterile, remember - is considered potentially dirty and is no longer touched with sterile or gloved hands. Similarly, a citizen wearing the mask never touches the outside of the mask again until it is removed.
- If nostrils come out of the mask they infect it massively on its external face and if the mask is then put back on it becomes a virus nebulizer! Same thing if you wear the mask around your neck for a while and then put it on again!
- To remove the mask without contaminating your hands, touch the elastic bands or straps only.

These rules are really very simple. In fact, it would only take a TV spot lasting less than a minute to spread this information and considerably and permanently improve the wearing of the mask by the general public.

It is said that if you are not used to a face mask, you tend to wear it poorly, especially if it is made of cloth.

- It is true that people who are little used to wearing face mask tend to wear it more loosely than those who are used to it. It is also true that wearing a homemade fabric mask is less comfortable than wearing a genuine surgical mask.
- This, however, does not take away all the mask's efficiency. At worst the face mask already helps grounding the wearer's breath after contact with the fabric (and absorption of viruses) and thus reduces the range of the aerosolized cloud, which is already most useful.
- Children rarely have a well-fitting mask. But even for them, wearing a mask has a fairly good efficiency, 8% less than that of adults, but still appreciated. The age when children start to tolerate a mask is unknown and may be different from child to child.
<https://smartairfilters.com/en/blog/diy-homemade-mask-protect-virus-coronavirus/>
- Finally, the general public rarely wears a fabric mask for as long as professionals have to. Going shopping, for a walk, chatting on the street with an acquaintance rarely takes six hours...

THE CITIZEN FACE MASK: A MUTUAL PROTECTION⁴

Don't wear a face mask to protect yourself,
Wear it to protect others!

Even though the face mask will also protect you.

A face mask is a personal item: it cannot be shared!

(not even within the close family)

- 1- Do not buy face masks from the chemist or pharmacy : keep those for the caregivers. Make your own mask (or get a home-made mask), from cloth. Youtube is full of good tutorials. And **let's dare using colours**: even if your smile can't show, it will cheer people up.
- 2- You don't need anyone's autorisation to wear an home-made mask.
- 3- Wear your face mask **continuously** in public places or at work, and whenever you are in the presence of someone who is not a close family member you live with at home.
- 4- Your face mask shall cover the **nose AND mouth** at all times. If the nose comes out of the mask, it infects the outside of the mask and the mask becomes a virus nebulizer.
- 5- Infection-wise, the "dirty" side of the mask is the one in contact with the nose and mouth of the person wearing it; fingers are not to touch the clean side of the mask!
- 6- Never put your hand on your face; it is the nose that carries the virus.
- 7- The face mask is **washed every evening**, with soap, rinsed with very hot water (>60°, or "simmering water": when bubbles start to form in the pan, just before water boils) and if possible steam ironed. Drying in the sun is also useful: sunlight (UV rays) also kills this virus - albeit slowly.
- 8- Do not put your face mask in your pocket: it can be contaminated and/or could contaminate your pocket.
- 9- Even when wearing a face mask, keep a **safe distance** of 1.5 m from people you meet and talk to.
- 10- **Don't talk much**. Even with a face mask, avoid conversations that are not essential and limit their duration to the bear minimum. Don't raise your voice.
- 11- Wash your hands, wash your hands, wash your hands... And **SOAP does work!**

And... people with face masks are not seen as a nuisance anymore, be thankful : they do it for **your** safety.

Professor Emeritus Philippe Baele, Anesthesiology
University Clinics Saint Luc UCLouvain, Belgium.

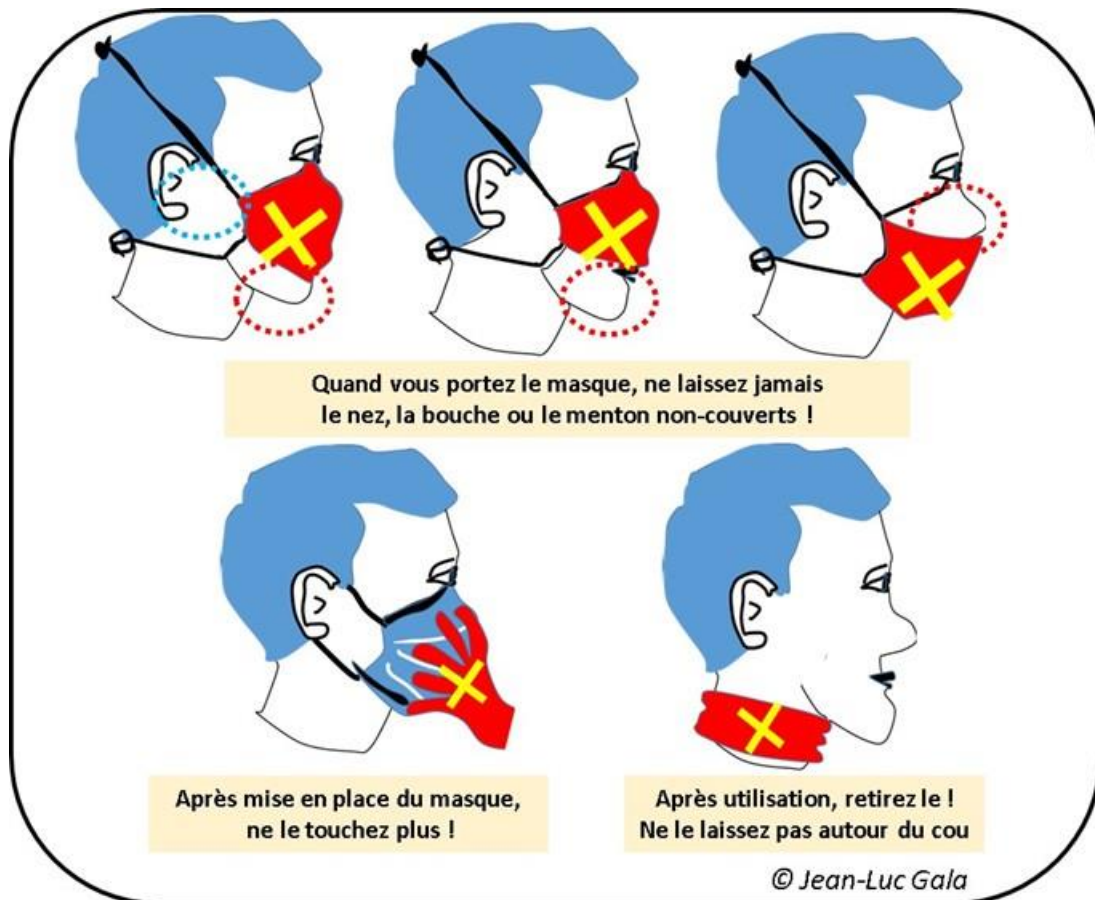
PRACTICAL NOTE :

Face masks for people who wear eyeglasses are fitted with a wire to tighten them on the nose, in order to restrict fogging of the glasses.

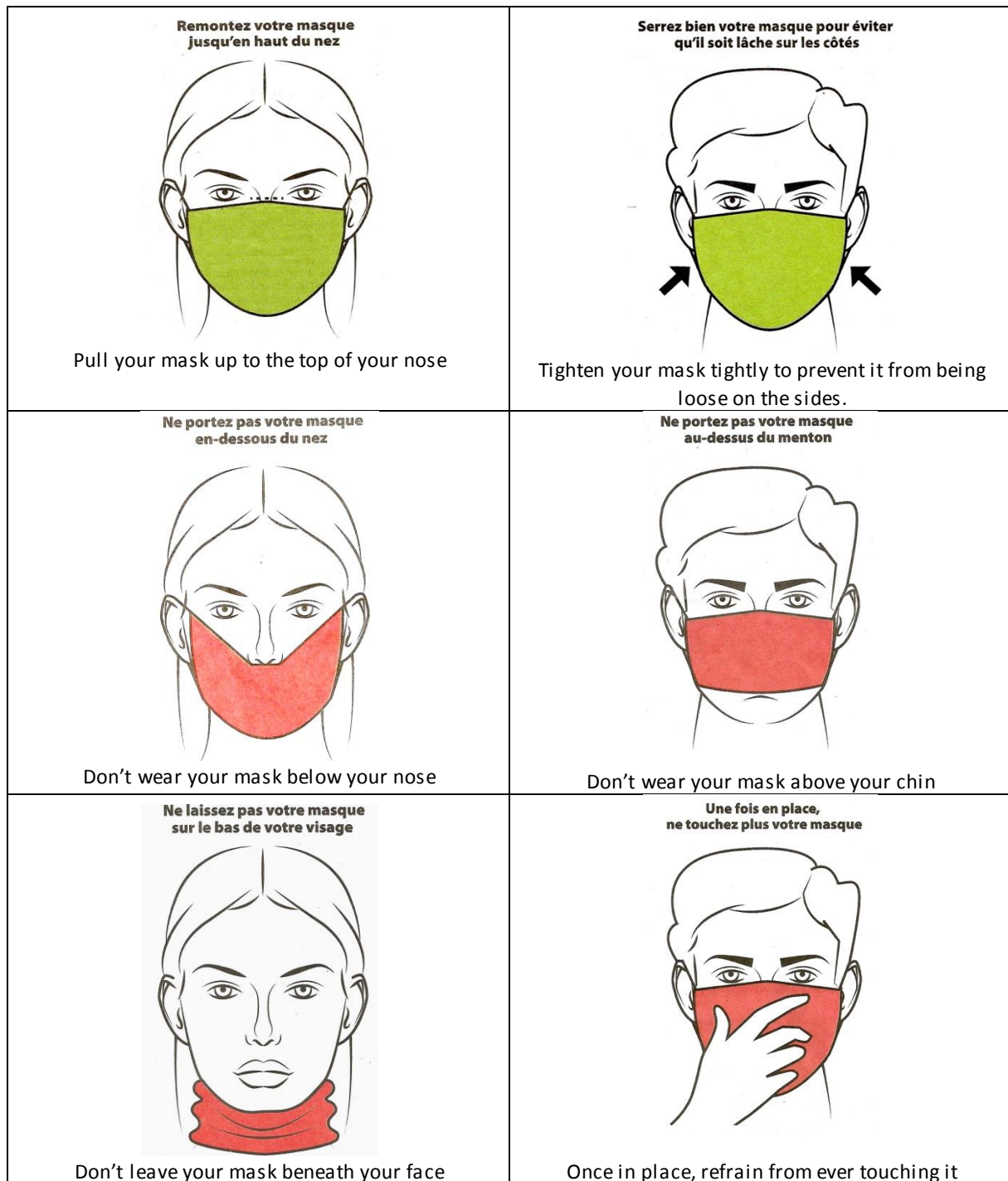
Face masks are to **open at the top or bottom** to allow a filter paper to be introduced. It is therefore possible to insert a filter such as a double layer of kitchen paper (paper towel), coffee filter (such as Melitta), dry "Swiffer" wipe or polyester fabric to provide added protection. This filter is single-use, remove before washing and insert the new filter into a clean, dry mask.

⁴ Proposed notice to give with each new mask made of cloth.

Wearing your face mask properly



When wearing a mask, never let nose, mouth or chin uncovered.
After donning the mask, don't touch it any more.
After using it, do not let it hang around your neck.



Adapted and translated from LE SOIR, April 22nd 2020

The nose is both the entrance gate of the virus into the body and its main spreading source. If the nose emerges from the mask and you are not contaminated, the mask does no longer protects you. If it comes out of the mask and you unknowingly harbour the virus, your nose contaminates the outer side of the mask and makes it a true virus nebulizer !

Summary of: CONTAGION BBC Documentary

Code name: "BBC PANDEMIC".

Documentary produced in 2018 by Hannah Fry and Javid Abdelmoneim.

Design: University of Cambridge and London School of Hygiene and Tropical Medicine

These are two life-size experiments that have proven to be prophetic...

It sets out to study how a pandemic⁵ influenza would spread in Britain, starting with a virtual "patient zero". The simulation was carried out using the geolocation of a large number of volunteers through their smart-phones. The initial assumptions are that it is an airborne (respiratory) virus. The contact times and the distance between individuals allowing contagion were pre-determined from the last seasonal influenza epidemics. All volunteers are presumed to be un-immunized to the new virus at the beginning of the experiment.

The first experiment was to see how a virus spreads **in a small community** from a single "zero" patient, a resident of the small town of Haslemere (population 16,800), who came back from a trip abroad with a common sore throat and mild headache, which she blames on air travel. For this experience 500 volunteers were geolocated every 5 minutes for 3 days. The software makes it possible to visualize who meets whom, where, when and for how long. The software virtually "infects" healthy volunteers who come into contact with another already infected volunteer according to pre-established criteria of location (closed or open), proximity and duration of contact. Each "infected" individual can then transmit the virus after a given period of time. Patient Zero takes a yoga class, goes to the library, the hardware store, has coffee with a friend at a terrace, goes to the supermarket and ends her day at the pub.

Results:

- **Within 72 hours, 86% of the volunteers are infected and the disease is present in every part of the city: the epidemic is out of control.**
- 46 super-propagators were identified (who infected >3 other participants).
- A simulation shows that if these 46 people were known beforehand and vaccinated from the outset, there would have been 46% fewer victims.

The second experiment recruited 28,965 volunteers from **all over Great-Britain** and located them every hour for 4 months. A "R0" transmission rate of 1.8 was assumed, which corresponds to that of a seasonal flu. By comparison R0 for Ebola = 2 and R0 for chickenpox = 20!

Results:

- in 4 months 43 million Britons were "contaminated" and 886.877 "died".
- It took 1 month for the epidemic to travel from Haslemere and spread to all in London.
- Then all other cities were infected and then remote areas.

Prophetic...

⁵ Pandemic, as opposed to seasonal, means that a major mutation of the virus has meant that it is no longer recognized by the immune system of the populations it affects.