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Analysis of the medical, political, administrative, and cultural argumentation lines in the context of COVID-19

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Analysis of the medical, political, administrative, and cultural argumentation lines in the context of COVID-19

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Abstract

The first part of the report contains a review of existing medical literature concerning the filtration capacity, benefits, and disadvantages of facemasks. It shows that the benefits of facemasks have been verified in dozens of filtration studies, aerosol simulations, population level simulations, country specific mortality statistics, observational studies, and RCT studies. The health risks related to facemasks are minor, and the ecological and economic costs of facemasks may be minimized by the reuse of masks.

The latter part of the report focuses on analyzing those discourses, paradigms and memes that led to mask-sceptic statements in healthcare institutions like FDA, CDC, Surgeon General, ECDC and the Finnish ministry of health (STM), to distribute highly skeptical and sometimes even fallacious statements about facemasks. The consequence of these statements was that some schools and grocery store chains in Finland prohibited facemask usage from their employees in the summer 2020.

The central reasons for the exaggerated statements and actions against facemasks were found to be the political argument "*we do not have enough masks for healthcare professionals*", the bureaucratic discourse, discourses of healthcare regulation, exaggerated forms of evidence-based medicine, and the culturally conservative discourses that discouraged Western countries to learn from Asian countries. The analysis of these discourses was performed by using memetic discourse analysis as its method. At the end, the authors give their suggestions to healthcare bureaucracies, concerning the best decision-making and communication practices for the times of crisis, uncertainty, and lack of time.

Key words: facemask; corona virus; COVID-19; pandemic; discourse; meme; misinformation; evolution

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1. Background, objective and concepts

1.1. Background and objectives

The recommendations of the WHO and the European Center for Disease Prevention and Control (ECDC), to combat influenza pandemics and COVID-19, have changed quite frequently over the last 12 months. The countries' recommendations have also changed, with a large number of Europe's originally 'mask-skeptical' countries recommending or making compulsory the use of facemasks in certain situations, such as shops, malls and means of transport, in the spring of 2020.

Finland and the other Nordic countries are exceptional because they had not yet recommended the use of facemasks at the end of May. STM commissioned its own study on facemasks, which concluded that there was no scientific basis for mask recommendations (STM 2020b). Immediately the following week, a comprehensive report funded by the WHO was published recommending the use of facemasks to combat the COVID-19 pandemic based on scientific evidence (Chu et al 2020). The science panel appointed by the Finnish government and the eroonkoronasta.fi group of Finnish researchers also recommend the use of facemasks to Finns based on scientific evidence.

The purpose of the first four chapters of this research report is to describe the advantages and disadvantages of different types of facemasks from the perspective of filter technology, medicine and economics. At the end, the aim is to use discourse analysis and administrative sciences for analyzing the historical, cultural, political and bureaucratic reasons that prevented Finland and other Nordic countries from recommending facemasks during the spring and summer of 2020.

1.2. Conceptual analysis

In the literature, facemasks are generally classified into three main categories:

1. Respirators
2. Medical masks (surgical masks)
3. Cloth masks.

This division, however, is somewhat misleading because cloth masks were widely used as respirators against Manchurian plague in the early 1910s (Lynteris 2018). Even today, it is still possible to make a high-protection respirator out of fabric (e.g. Dato et al. 2006), but it can no longer be called a respirator due to the laws and regulations concerning occupational health. The overlap of facemask concepts is illustrated in the figure below:

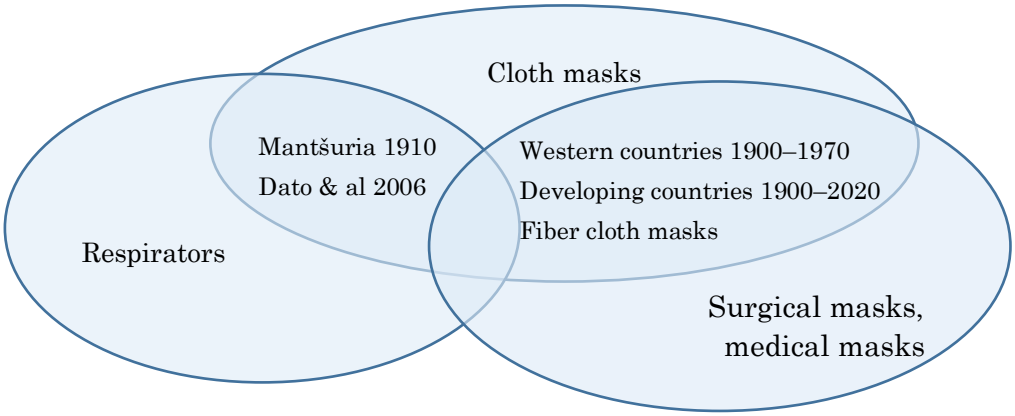

Figure 1: Facemasks as historical and cultural concepts

The lower right-hand side of the figure shows that all medical facemasks are still made of fabric, although the fabric used is fiber cloth, which is a new type of cloth that is produced with *melt blown technology* instead of using a woven or knitted fabric. The separation of cloth masks and medical masks is also artificial, as woven cloth-masks were still used as medical mouthpieces in the western countries until the 1970s, and have continued to be used in developing countries until the 2020s. In Europe, too, cloth masks were widely used by healthcare workers during the COVID-19 epidemic, especially in home care during the shortage of disposable fiber cloth masks in spring 2020.

Some health authorities like STM (2020b) have tried to avoid this confusion by classifying facemasks according to their intended use, classifying respirators for demanding professional use, medical masks for healthcare professionals, and other masks for consumer use. This classification does not take into account the fact that also citizens have the right to acquire masks with a higher level of protection if they wish. It seems that the STM classification is constructed based on a political argument, which directs citizens not to use surgical facemasks or respirators – as there is a shortage of them, and therefore STM suggests that they should be reserved for healthcare professionals. This example shows that even the definitions may be political in their nature, and not purely scientific and objective.

In this report, the facemasks relevant for the control of pathogens are classified according to their *physical properties* into the following categories:

1. Respirators

a. Half masks with a separate filter
b. Filtering half masks:
    - Half masks according to EU OSHA and US NIOSH standards in categories FFP1, FFP2, FFP3, N95 and N99
    - Other half masks, which one may not call respirators in Europe and USA in the 21st century, such as
        i. half masks made by Chinese standards
        ii. Do-it-yourself respirators that have a high filtration capacity[†]

2. Fiber cloth masks (produced with melt-blown technology)

a. Surgical masks complying to Western standards
b. Surgical masks complying with Chinese standards
c. Community masks complying with Chinese standards (e.g. GB/T32610-2016)
d. Unclassified fiber cloth masks (community masks)

3. Cloth masks

a. Woven
b. Knitted
c. Microfibers (may be woven or knitted)

The term *community mask* normally refers to fiber cloth masks that are produced for consumers. They usually have a slightly inferior filtering capacity compared to surgical masks, and better capacity compared to woven and knitted cloth masks. Yet, the filtration capacities of facemasks vary substantially within each category, depending on the physical properties of the mask (e.g. double layer or one layer) and on the material and brand of the mask (see chapter 2.3). In addition to facemasks, there are also *visors* that prevent larger sputum, blood and secretion droplets from splashing on the wearer's face. They are discussed only to a limited extent in this paper.

Other basic concepts of this report include the *SARS-CoV-2* virus, which belongs to the group of coronaviruses and the *COVID-19* disease, which is the symptomatic disease caused by the SARS-CoV-2 virus to about 20–80% of the carriers of the virus.

Respirators, facemasks and visors are classified as *non-medical interventions* in medical texts, whereas interventions, in general, are methods, equipment, medicines or treatments for intervening with the spread or development of a disease. The evaluation of the benefits of interventions usually takes place within the framework set by *evidence-based medicine* (see chapter 5.5).

[†] Instructions given e.g. by Dato et al. (2006) and the Consumer Council of Hong Kong (2020)

1.3. Methodology

The study started with the identification of the public healthcare authorities that gave facemask related the statements in Finland April 2020 or had a direct influence on these statements. The Finnish Ministry of Social Affairs and Health (STM), the European Center for Disease Prevention and Control (ECDC) and the International Health Organization (WHO) were identified as the key healthcare authorities. The next step was to examine the reports that these authorities had published about influenza control measures before June 2020. At this stage, 300 references to scientific articles were found, out of which 27 related to surgical masks or to cloth masks.

The systematic literature review described above was supplemented by a *hermeneutic literature review* (see Kalfe 2011), which aims to increase understanding of the phenomenon under study, to break away from preconceptions, and to find information or latent perspectives that fall outside commonly accepted paradigms, knowledge, and beliefs. Hermeneutic literature research proceeds in a spiral, improving understanding and argumentation from round to round. In this study, the simplest way to start a hermeneutic study was to search the Internet freely for keywords related to facemasks. This provided an opportunity to find existing literature reviews on facemasks, such as Jefferson et al. (2011) and Howard et al. (2020). This study revealed some clear paradigmatic differences in the attitudes of the academia towards the widespread use of facemasks among asymptomatic citizens. The facemask positive paradigm, together with scientific references, appeared mostly around the literature study of Howard et al. (2020), whereas Brosseau and Sietsema (2020) and Blaylock (2020) represented the facemask sceptic paradigm.

The effect of paradigms is based on the tendency of people (including researchers and authorities) to avoid *cognitive dissonance*, that meaning the conflict between existing beliefs and new, contrary information (Festinger 1957; see also Kuhn 1971). Therefore, paradigms cause their supporters to seek information that supports the paradigm and to reject information that is contrary to the paradigm. Outside observers can turn paradigm disputes to their advantage by seeking scientific information from the arguments and references cited by each competing paradigm. On this basis, both the 52 articles mentioned in the bibliography of Brosseau and Sietsema (2020) and the 96 articles mentioned in the bibliography of Howard et al. (2020), were included in the literature study. Because the research method was hermeneutic, this cumulated research material was further supplemented at the stage when the article's authorship expanded from one to five and when comments and citations suggestions were received from several commenters. A summary of the literature sources is presented in Appendix table 1

The interpretation of research material was based on *memetic discourse analysis*, which is a research method that combines discourse analysis with memetics (see Malmi 2009). The purpose of memetic discourse analysis is to deconstruct and restructure paradigms and discourses into *discursive elements* (see Habermas 1984), i.e. *memes* (Dawkins 1976). The origin of each meme is then backtracked to its historical antecessors, with

the intention of trying to find the origin of each meme. In this respect, the study resembles studies of virology and epidemiology, in which one tries to backtrack the contagion paths from current moment to the earliest appearance of the virus. The similarity between memes and viruses was originally noted and analyzed by Dawkins (1976/1993).

In addition to the memetic discourse analysis, the research material was also studied from the point of view of epistemology and philosophy of science, in order to analyze the validity of different statements presented by the proponents of the mask sceptic and the mask positive paradigms.

2. Efficiency of masks as a protective measure against viruses

2.1. Routes of virus contagion and the mechanic benefit of facemasks

Typical modes of infection of viruses that cause respiratory infections include 1) Aero sol infection, 2) droplet infection, and 3) contact infection (Kutter et al. 2018). Contact infection occurs on contaminated surfaces that may have become contaminated, for example, when droplets containing pathogens settle on the surface. The second step in contact infection is when pathogens are transported from a contaminated surface to human mucous membranes, for example, when a person touches their face with contaminated hands. In droplet infection, pathogens use larger droplets born through coughing or sneezing as a means of migration. In aerosol infection, the infection is transmitted by a gas (e.g., air) containing small droplets. Aerosol droplets are classified as droplets smaller than 5 micrometers (Kutter et al. 2018). For comparison, it is good to know that the SARS-CoV-2 virus is about 0.12 micrometers in size, or about 2.4% in diameter, and about 0.001% in volume of the largest aerosol droplets. Due to this, the standard filtration tests that relate to surgical masks focus on measuring filtration capacity against particles of 3 microns, while respirators are tested also with smaller particles (0.1 microns). The filtration capacity of facemasks against virus-sized particles is relatively irrelevant.

Studies show that aerosol, which contains viruses, is produced not only by coughing and sneezing, but also by singing, shouting and speaking. Inhalation alone also produces aerosols. (Asadi et al 2019, Milton et al. 2020). "Aerosol emission and superemission during human speech increase with voice loudness). According to Yu (2004), Santarpia et al. (2020) and Esposito et al. (2020), aerosols are the major route for the transmission of SARS-CoV viruses 1 and 2.

The most significant benefit of masks is based on their ability to filter aerosol droplets containing viruses. This filtering takes place during inhalation, which protects the mask wearer from viruses secreted into the air by other people. Masks also protect other people from viruses produced by the mask wearer during exhalation, speech, coughing, and sneezing.

Different masks protect against aerosol droplets of different sizes. Fabric masks provide protection mainly against drops of more than 3 micrometers, while the best surgical masks and respirators also protect their wearer against small aerosol drops that spread like tobacco smoke. Entire rooms can be filled with small aerosols containing the virus and therefore good ventilation is an important factor in combating viral epidemics (Doremalen et al. 2020). The simulation of Aalto University, the Finnish Meteorological Institute, VTT and CSC – Center for Science Information Technology Ltd also suggests the same, according to which a safety distance of 1–2 meters is not sufficient, especially if exposure to the virus carrier lasts a few minutes longer (Auvinen and Hellsten 2020, see also Setti et al. 2020).

The history of respirators and theories of disease transmission are interlinked: In the Middle Ages, people believed that "bad air" spreads diseases (Lynteris 2018). This explanatory model, which is actually quite similar to modern aerosol theory, was rejected in Western countries after the invention of bacteria: For example, at the time of Manchurian plague European doctors believed that the plague was transmitted through bacteria carried by rats and fleas. When Doctor Wu Lien-teh, based on his autopsies, suggested that plague was transmitted through air, he was not initially believed, and European doctors did not believe that the Wu's facemasks could protect their wearer from infection. However, Wu's research gradually led to the development of FFP-level filterable half masks, and Wu was nominated for a Nobel Prize in 1935.

There are three alternative ways for evaluating the value of respirators and facemasks as non-medical interventions against airborne diseases:

1. *Occupational health* point of view (see chapter 5.7) is based on the laws that intend to protect employees against health hazards. This point of view tends to lead to the conclusion that facemasks do not protect their wearer at all against viruses, unless the masks filter at least 80% of the particles at the size range of 0.3 microns (0.0003 millimeters).

2. *Contextual risk reduction* point of view will conclude that respirators, fiber cloth masks and cloth masks offer protection to their wearer. Yet, each situation or context may require a different level of protection: If one works in a hospital with COVID-19 patients, and is exposed to high quantities of virus aerosols, even a respirator that filters 99% of small aerosols may not give sufficient protection. On the other hand, a person who is exposed only temporarily and from a distance of a couple of meters, may get sufficient protection with a surgical mask or a cloth mask, especially, if one compares this protection to the alternative of using no mask at all.

3. *Source control* point of view will lead to the conclusion that masks should be used to protect others from the viruses that the mask-wearer may be carrying – possibly without knowing that their infection. This conclusion comes from

> the fact that coughing, sneezing, speaking and even breathing produce virus aerosols. These aerosols will partially remain in the mask without risking other people and this means that all mask usage is beneficial, even if the masks may not give full protection to their wearer against infections.

This report makes use of points of view 2 and 3. An additional justification for this choice is the fact that the contagion of SARS-CoV-2 virus to a person may not necessarily cause COVID-19 disease. What is essential for the appearance of the disease and its symptoms is the viral load that a person receives (Gandhi, Beyrer & Goosby 2020). As the masks will reduce the viral load both as source control mechanism and as a contextual risk reduction method, less people are likely to develop symptoms, as less viruses will end-up to the respiratory system.[‡] This additional justification for mask usage is supported by studies of the SARS-CoV-2 epidemics that spread on specific cruiser ships: On the Diamond Princess ship masks were not used and the percentage of symptomatic patients was 80% out of all persons carrying the SARS-CoV-2 virus (Mizumoto et al. 2020). Later on, all passengers on the Ernest Shackleton ship were ordered to use facemasks, and the percentage of symptomatic patients dropped to 20% (Ing, Cocks & Green 2020).

2.2. Filtration capacity of standardized facemasks

International standards define different types of facemasks and set requirements for their filtering ability. The requirements for respirators are the highest ones, i.e. they must be able to filter almost all of the most difficult to filter particles, which are 0.3 microns in size. Standard surgical masks must also have a relatively high filtration capacity, but that concerns times larger particles (3 microns) which are not so difficult to filter. The following table shows the different standards and the filtration requirements for compliant masks. In order for a mask to fall into the category of the standard under consideration, the mask manufacturer must demonstrate, using the tests specified in the standard, that the level of protection of the masks comply with the standard.

[‡] See also Nature 586, 186–189 (2020).

Mask Type	Standards	Filtration Effectiveness		
Single-Use Face Mask 	**China:** YY/T0969	Open-Data Tests Smart Air SmartAirFilters.com 3.0 Microns: ≥95% 0.1 Microns: ✕		
Surgical Mask 	**China:** YY 0469	3.0 Microns: ≥95% 0.1 Microns: ≥30%		
	USA: ASTM F2100	Level 1	Level 2	Level 3
		3.0 Microns: ≥95% 0.1 Microns: ≥95%	3.0 Microns: ≥98% 0.1 Microns: ≥98%	3.0 Microns: ≥98% 0.1 Microns: ≥98%
	Europe: EN 14683	Type I	Type II	Type III
		3.0 Microns: ≥95% 0.1 Microns: ✕	3.0 Microns: ≥98% 0.1 Microns: ✕	3.0 Microns: ≥98% 0.1 Microns: ✕
Respirator Mask 	**USA:** NIOSH (42 CFR 84) **China:** GB2626	N95 / KN95	N99 / KN99	N100 / KN100
		0.3 Microns: ≥95%	0.3 Microns ≥99%	0.3 Microns ≥99.97%
	Europe: EN 149:2001	FFP1	FFP2	FFP3
		0.3 Microns: ≥80%	0.3 Microns: ≥94%	0.3 Microns: 99%

3.0 Microns: Bacteria Filtration Efficiency standard (BFE).

0.1 Microns: Particle Filtration Efficiency standard (PFE).

0.3 Microns: Used to represent the most-penetrating particle size (MPPS), which is the most difficult size particle to capture.

✕: No requirements.

Figure 2: Standard requirements for facemasks (SMART AIR 2020)

In the EU, standards for respiratory protection are set by the European Agency for Safety and Health at Work (OSHA); in the US, the responsible authority is NIOSH. Although the 3.0-micron filtration requirement is referred to as the "Bacterial Filtration Efficiency" (BFE), the filtration efficiency of particles in this size class also means that the mask filters viral aerosols of that size class. For example, a class II surgical mask according to EN 14683 filters 98% of aerosols of this size. When the percentage is so high, the filtering ability *sounds good*. If, on the other hand, facemasks are tested from the strictest occupational health point of view, the tests are performed on 0.3-micron particles, which are very difficult to filter. In this case, it is easy to conclude that surgical masks are of *almost no use* and fabric masks are of *no use at all*.

When assessing the filtration capacity, it is therefore necessary to check the size of the particles for which the tests have been performed.

2.3. Studies concerning filtration capacity

Although the filtration capability of respirators and classified surgical masks is in principle already defined in the relevant standards, masks have still been extensively tested in scientific studies as well. Cloth masks or different fabric qualities have often been used as a reference. In these tests, the most common method has been to blow air that contains particles of 0.3 to 3 micrometers in size, through a facemask or fabric at different airflow rates. The most commonly used speeds are 5.5 cm / s, 16.5 cm / s and 28.3 l / min. [§]

In spring 2020, VTT investigated the ability of four different facemasks made of fabric to filter particles between 0.65 and 3.3 micrometers in tests according to the SFS-EN ISO 29463-3: 2018 standard at a flow rate of 28.3 l / min. [**] According to the results, the filtration efficiency of cotton fabrics was 19.6–28.6%, while the filtration efficiency of polyester fabrics was 39.2–42.4% (Karvinen et al. 2020, 3).

Rengasamy, Eimer, and Shaffer (2010) measured the *penetration rate* (percentage) of different fabrics, which can be converted to filtration efficiency by subtracting the penetration percentage from one. Of the fabric options, Hanes Sweatshirt fabric, made of 70% cotton and 30% polyester, offered the best filtering efficiency, 60% against the NaCl aerosols. This percentage was higher than the filtration efficiency of some surgical masks that had been approved by Food and Drug Administration (FDA), and which had been studied earlier by Rengasamy et al. (2009).

Davies et al. (2013) artificially produced an aerosol under laboratory conditions containing *Bacillus atrophaeus* (1.2 micron in size) and MS2 Bacteriophage (0.023 microns) in another experiment. According to the study, the cotton blend fabric filtered 70.2% of bacteriophages and 74.6% of Bacillus atrophaeus bacteria, whereas the filtration capabilities of a Class I surgical mask were 89.5% against viral phages and 96.4% against bacteria.

Jung et al. (2013) examined a larger number of different masks on the market with particles smaller than micrometers smaller than micrometers, i.e., the size class roughly corresponded to the particle size used in respiratory tests (0.3 micrometers). The main results are summarized in the table below:

[§] This is the flow of air mentioned in the standard SFS-EN 14683:2019 + AC: 2019 – Medical face masks. Requirements and test methods.

[**] Based on the standard SFS-EN ISO 29463-3:2018 – High-efficiency filters and filter media for removing particles in air. Part 3: Testing flat sheet filter media.

Table 1: Comparing the filtration efficiency of surgical masks and cloth masks

Mask type	Filtering efficiency according to KDFA tests	Filtering efficiency according to NIOSH-tests
Standardized surgical masks	59%	59%
Unclassified fiber cloth masks	47%	55%
Cloth masks	30%	48%

When interpreting the results of Jung's research team, it should be noted that in the group of surgical masks and cotton masks, there was a very large dispersion in filtration capabilities. This means that these types also included facemasks with clearly better filtration capacity.

Shakya et al. (2016) investigated the filtering capacity of different masks against aerosol particles of sizes 0.03–2.5 microns. The best surgical mask filtered 80% to 90% and the best cloth masks filtered 39% – 65%. The filtration results varied according to particle size, causing the above-mentioned ranges.

According to the Consumer Council of Hong Kong, a self-made facemask made of fabric (towards the skin) and a double layer of tissue paper on the outer side, will filter particles of sizes 0.02–0.2 micron at a filtration capacity that is 90% of the capacity of a industrially made surgical mask (Consumer Council of Hong Kong 2020). The council recommended that everyone should consider using a self-made mask if there is a shortage of surgical masks.

Table 2 summarizes the studies, presented above, concerning the filtration capabilities of different types of facemasks. The results of different studies cannot be compared directly to each other, because the research methods and particle sizes varied from study to study as well as within the same study. For example, Jung et al. (2013) performed measurements according to both the KDFA standard and the NIOSH standard.

Table 2: Summary of the filtration efficiency of various masks and cloths

Mask type	Filtration efficiency	Research group and an explanation of the measurements	Particle size
N95 respirator	99.9%	Rengasamy, Eimer and Shaffer (2010), one brand of respirators	3 microns
Surgical facemasks	89.5–96.4%	Davies et al. (2013)	0.02–1.2 microns
	59% (KDFA) 59% (NIOSH)	Jung et al. (2013), average measure of various brands	nanoparticles (below 1 micron)
Unclassified fiber cloth masks	47% (KDFA) 55% (NIOSH)	Jung et al. (2013), average measure of various brands	nanoparticles (below 1 micron)
	80–90%	Shakya et al. (2016)	0.03–2.5 microns
Cloth masks (cotton-polyester)	70.2–74.6%	Davies et al. (2013) one arbitrarily selected fabric	0.02–1.2 microns
	60%	Rengasamy, Eimer and Shaffer (2010), one arbitrarily selected fabric	3 microns
Cloth masks (polyester)	39.2–42.4%	Karvinen et al. 2020, two different fabrics	0.65–3.3 microns
Cloth masks (unspecified material)	39–65%	Shakya et al. (2016)	0.03–2.5 microns
Cloth masks (cotton)	30% (KDFA) 48% (NIOSH)	Jung et al. (2013), average of several different mask brands	nanoparticles (below 1 micron)
	19.6–28.6%	Karvinen et al. 2020, two different fabrics	0.65–3.3 microns

Comparisons can be made between the results obtained for different masks, reported by the same group of researchers. According to the results of Davies et al. (2013), the filtration efficiency of surgical masks was about 1.3 times the efficiency of polyester-cotton masks. According to the Consumer Agency of Hong Kong, the filtration efficiency of surgical masks is only 1.1 times the filtration capacity of facemasks made of fabric and paper, but insufficient source references were provided to verify the information. According to the results of Rengasamy et al. (2010), the filtration efficiency of the N95

respirator against particles of 3 microns, was 1.7 times higher than the filtration efficiency of cotton-polyester cloth masks.

From a practical point of view of the mask users and buyers, it is not so relevant, how much the worsts cloth masks and the worst surgical masks filter – or what is the average filtration efficiency within each mask category. Instead, it is more productive to concentrate on pointing out the best surgical masks and best cloth masks, so that authorities and consumer councils can direct people towards rational choices. One step towards that direction is the finding that cotton-polyester mixture masks and polyester masks seem to be almost two times better than cotton masks: For example in the study of Karvinen et al. (2020), the filtering efficiency of polyester masks was 1.5–2 times better than the filtering efficiency of the cotton masks of the same breathing resistance.[††] A more detailed analysis of the best practices for comparing cloth masks types and brands to each other is given in chapter 4.3.

In addition to the technical measurements described above, the effect of protective fabrics assimilated to surgical masks has also been studied in animal experiments in laboratory conditions. In their study, Chan et al (2020) positioned a cage of healthy animals next to the cage of virus-infected animals and found out that 67% of the healthy animals were soon infected with the virus. When a fiber cloth, equal to the one used in surgical masks, was positioned between the cages, only 25% of the healthy animals were infected. This means a 63% reduction in the probability of infection.

2.4. Filtration tests with human subjects

Sande, Teunis, and Sabel (2008) studied the filtering ability of a FFP2 mask, a surgical mask, and a fabric mask with a group of 28 adults and 11 children. Subjects were given a facemask, after which they were located for three hours to a space containing particles of 0.02 – 1 microns in the air. During the experiment, the subjects visited the outside of the test room at regular intervals to measure the particle concentrations inside the facemask. For each mask, the protection factors were then calculated by dividing the concentration of air outside the mask by the concentration of air inside the mask. Measurements were made in five different contexts to elucidate the effect of subject activity on the filtering ability of the mask. Activities included: 1) No activity, 2) nodding the head, 3) shaking the head, 4) reading, and 5) walking.

The protection factors for surgical masks and cloth masks ranged from 2.4 to 6.5. This means that the particle concentration on the protected side was 15% – 41% of the concentration on the unprotected side of the mask. The medians of the protection factors

[††] It is possible to increase filtering efficiency by adding multiple layers of cotton or by using microfibers, but this will also increase the breathing resistance. Therefore, one should not compare multi layered or microfiber masks with single layered cotton-polyester masks. If a comparison is made between masks of the same breathing resistance, polyester-cotton mixture and pure polyester masks will probably offer the best filtering efficiency, based on the research results reported by Rengasamy, Eimer, and Shaffer (2010) and by Karvinen et al. (2020).

for the different mask types within each activity are shown in Table 3. The minimum and maximum values are shown in parentheses:

Table 3: Comparing the protection factors of different facemasks used by human subjects

		no activity	nodding	shaking	reading	walking
Tea cloth	Start	2.8 (2.5–3.1)	2.4 (2.3–2.6)	2.5 (2.3–2.8)	3.4 (2.9–3.7)	2.4 (2.2–3.1)
	End	3.2 (2.7–3.4)	2.7 (2.5–3.0)	2.9 (2.6–3.4)	4.3 (3.5–5.2)	2.9 (2.8–2.9)
Surgical mask	Start	3.9 (3.4–6.1)	3.6 (3.1–7.1)	3.8 (3.7–7.3)	6.5 (4.3–7.2)	4.6 (2.9–6.4)
	End	4.4 (3.2–7.4)	4.5 (3.4–7.2)	4.1 (3.3–7.8)	5.9 (4.2–6.5)	3.9 (3.3–6.7)
FFP2 mask	Start	141 (34–196)	100 (26–156)	132 (54–265)	84 (47–194)	79 (10–167)
	End	53 (31–339)	48 (36–116)	42 (23–177)	92 (29–202)	43 (16–185)

If we try to find a suitable benchmark for a situation where a person wearing a mask tries to protect himself or herself with a facemask during a trade or other similar situation, the best benchmark is probably "walking". The protection factor 4.6 of the surgical mask, when the subject walked, was 1.9 times higher at the beginning of the experiment compared to the protection factor (2.4) of the "Tea cloth" type fabric mask. At the end of the experiment, however, the protection factor 3.9 of the surgical mask was only 1.3 times higher than the protection factor (2.9) of the cloth mask. This same increase in the filtration capacity of cloth masks and a decrease in the filtration capacity of surgical masks over time was also found during all other activities.

The protection factor 79 of the FFP2 mask, when the subject walked, was 33 times higher at the beginning of the experiment compared to the protection factor of the "Tea cloth" type fabric mask (2.4). However, at the end of the experiment, the protection factor 43 of the FFP2 mask was only 15 times higher than the protection factor of the cloth mask (2.9).

Adults received a better protective factor from the use of facemasks than children did. The differences were quite small for fabric masks, but surgical masks provided adults with almost 2 times better protection factor than they provided for children. For FFP masks, adult protection factors were up to 2 to 6 times higher than for children, depending on the subject's activity. The result suggests that the use of fabric masks works better in children than the use of FFP respirators or surgical masks. This may partially be due to the fact that most FFP respirators have been designed and sized for adults, meaning that there can be substantial leakages of air on the sides of the mask that are not firmly connected to the face.

In order to study the efficiency of facemasks as source control Sande, Teunis, & Sabel (2008) created an artificial head that exhaled an airflow that contained bacteria, and which was covered by a facemask. The concentration of bacteria was measured inside

the facemask and this inside concentration was compared to the concentration of bacteria outside the mask. The distance for measuring the outside concentration was not mentioned in the article, reducing the applicability of the results to practical situations with real people in different contexts. Considering this disclaimer, the study revealed that FFP-respirators offered a protection factor of 2.8–3.1 for the "outsiders" (persons not using the mask). The protection factor for surgical masks was around 1.7–3.1 whereas the protection factor for the cloth mask was only 1.2–1.3. The protection factor can be converted to a measure of filtering efficiency by dividing one with the protective factor. This conversion will result in the following filtering efficiencies for source control: FFP respirators 64–68%, surgical masks 61–68%, and cloth masks 17–23% of filtering efficiency.

Kelkar et al. (2013) compared the ability of cloth masks and 2-layered (two-ply) surgical masks to filter out pathogens emitted during speech. The 30 operating room staff members, selected as test subjects, were initially asked to say "ahh" at a distance of 10 to 12 centimeters from the bacterial culture medium. They then began to use the cloth mask and returned to the culture medium after 30, 60, 90, 120, and 150 minutes to repeat the same emission test. The next day, the same experiment was repeated using surgical nonwoven masks.

The filtering efficiency the facemasks, as methods of source control, was presented in tables that showed amount of bacteria culture medium 1) without mask, 2) with cloth mask, 3) with surgical mask, at different intervals of time, starting from the moment the mask was first used. Based on this information, it is possible to calculate filtering efficiencies for the cloth masks and for the surgical masks, by dividing the "without mask" concentration of bacteria with the results relating to mask usage at different time intervals. The results are summarized in Table 4.

Table 4: Outward filtering efficiency of surgical masks and cloth masks during speech

	Cloth masks	Two ply surgical mask
Without mask	0%	0%
After 30 min	88%	82%
After 1 h	60%	57%
After 1.5 h	27%	40%
After 2 h	14%	-5%
After 2.5 h	2%	-31%

The study revealed that source control capacity of both cloth masks and surgical masks starts to drop significantly after 1.5–2 hours of usage. Based on this, Kelkar et al. (2013) recommended changing the facemask at least every 90 minutes. Another interesting finding is the fact that the source control filtering efficiency of cloth masks and surgical

masks is almost the same during the first 60 minutes of usage. This finding conflicts with the results of Sande, Teunis, & Sabel (2008), which led to the conclusion that cloth masks offer a notably lower degree of protection for outsiders, as a method of source control.

The study of Ho et al. (2020) concluded that the differences of cloth masks and surgical masks as methods of source control are small.

2.5. Health benefits on the population level

Methods

The community-level health benefits of facemasks and other non-medical interventions can be elucidated by random control trials (RTC), meta-studies, and observational studies.

The reliability of the results obtained with RCT studies is measured by P-values, which reflect the probability that the study result in question was generated by chance: A smaller P value means it is less likely that the results would be based on random variation. Carrying out RCT studies on the population level is so challenging that for example, the benefits of hand washing, to intervene with epidemics, have not yet been statistically proven (Saunders-Hastings et al. 2017). Therefore, the possible lack of evidence from RCT studies does not yet mean that there will be no benefits.

Some of the problems of RCT studies can be tackled by meta-studies, which summarize the results of former RCT studies. This summary can be qualitative, listing and explaining the former research results, or quantitative, trying to merge the former studies together into a new statistical model, that will calculate the combined P values based on all the former RTC studies.

Observational studies are often case studies, based on a relatively small sample like all travelers that travelled on a cruise ship together with infected patients (e.g. Ing, Cocks & Green 2020). The risk of observational studies is the fact that the sample may be biased so that other variables are producing the observer result, not the intervention that are observed. Yet, observational studies can be used as a basis for decision-making, if sufficient RTC level evidence is not available (Cochrane Collaboration 2004).

Results

Jefferson et al (2011) examined 3775 scientific articles in their own meta-research and found seven RCT studies that examined the protective effect of a mask provider on mask users. Of these studies, with reference to a clear net mask provider protection in the hospital environment of health care personnel and two protective effects on the general population (Lau 2004a and Wu 2004). Jefferson's team of researchers concluded that the use of masks was necessary to protect the use of the mask from a perspective: "*Simple mask-wearing was highly effective based on seven studies*" (Jefferson et al. 2011). The term "simple mask", i.e. a simple mask, refers herein to unclassified fiber cloth masks, not to woven cloth masks.

In their meta-study, Barasheed et al. (2016) examined several previous studies that had focused on pilgrim gatherings in Mecca. This meta-study suggested that facemasks reduce the risk of respiratory diseases by 20% in mass events. These results, however, were not significant for any specific disease.

Xiao et al. (2020) conducted a literature search and a meta-study in which the 12 studies discussed found that the use of face shields did not reduce the spread of influenza in a statistically significant manner, but the same result also applied to hand hygiene. When the emphasis on hand hygiene and the use of facemasks were combined, a reduction in influenza morbidity was observed, but the result was not statistically significant.

In their literature review, Saunders-Hastings et al. (2017) found 17 relevant studies on non-medical interventions. None of these studies found statistically significant grounds to conclude, that facemasks or other non-medical interventions such as hand washing or cough etiquette, would be beneficial in combating influenza epidemics. However, researchers concluded that a combination of all non-medical interventions to combat epidemics: "*It is likely that an optimal intervention strategy will employ a combination of interventions in a layered approach, though more research is needed to substantiate this proposition*".

In their literature search and meta-analysis, Chu et al. (2020) found 44 relevant studies, seven of which were related to the COVID-19 epidemic and 37 to either the SARS or MERS epidemic. Of the relevant studies, 39 compared the protection provided by respirators to surgical masks and woven fabric masks. For each mask type, there was a clear and statistically significant reduction in the risk of infection compared to not using the mask. ‡‡ The study also found a statistically significant result, according to which maintaining social distance, i.e., safety distances, prevents the epidemic. Each additional meter brings more security: For example, a safety distance of two meters reduces the risk of infection by half compared to a safety distance of one meter. If we compare the effect of the extension of the safety distance with the facemasks, then the extension of the safety distance from 1 meter to 2 meters would seem to have a less protective effect than if a person had a safety distance of 1 meter and introduced a fabric mask. However, this set of comparisons is mainly indicative, as Chu et al. 2020 are not directly proportional to the studies presented in Chapter 2.4.

Brainard et al. (2020) found 28 relevant studies that underwent narrative synthesis as well as meta-analysis. Of these, only three were RCT studies and the rest were observational studies. RCT studies found (very) little benefit from the use of facemasks. Greater benefits were found in the observational studies: When all family members wore a facemask in a family whose one member had been infected, the likelihood of the other family members becoming ill decreased by 19% (statistically significant). The protective effect was very small if only healthy family members wore a facemask.

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‡‡ STM 2020 mainitsee tämän tutkimuksen lähdeluettelossaan, mutta päätyy silti johtopäätökseen, jonka mukaan tieteellistä näyttöä kasvomaskien hyödyistä ei ole.

Beldomenico (2020) and Shen and Bar-Yam (2020) have analyzed the impact of asymptomatic superinfectors on the spread of the COVID-19 pandemic. Kenyon (2020) has argued that large-scale use of masks is necessary to protect communities from infections transmitted by superinfectors.

Bundgaard & Bundgaard (2020) created in Denmark a random sample of 4862 persons, out of which roughly 50% were recommended to use a mask and the rest did not receive such a recommendation as at the time of the study, the Danish government did not yet recommend facemasks and the usage of masks was highly uncommon. After 1 month, the appearance of virus antibodies was measured in both groups. According to the results, 1.8% of the mask-users and 2.1% of the control group, had developed antibodies or had been diagnosed in a hospital as COVID-19 patients. The results indicate that people, who have been advised to use masks, have a roughly 11% lower risk of being infected than those who do not receive such a recommendation. This figure, however, does not yet take into account the source control benefit of facemasks. In addition, we must keep in mind that recommendation to use masks does not yet mean consistent mask usage – or proper mask usage.

Leffer et al (2020[§§]) compared mortality rates relative to population in different countries and found that mortality was up to 300-fold higher in Italy and Spain compared to Japan, Hong Kong, and Taiwan. According to Leffer et al, this was caused, at least in part, by the widespread and common mask usage in countries with lower mortality. This interpretation is supported by a study of Cheng et al. (2020), who compared infection and mortality rates in different countries for the first 100 days of an epidemic. The study showed that although factors like population density, health care levels, vaccinations, and restrictions on social distance are standardized, widespread use of masks significantly reduces the number of COVID-19 infections per million inhabitants. In countries where the use of masks was widespread and common, only 129 to 260 infections per million inhabitants were registered (Hong Kong, Singapore, South Korea), while in other countries 832 to 2983 infections per million inhabitants were registered (Spain, Italy, Germany, France, United States and the United Kingdom). The differences were statistically significant ($P < 0.001$).

Based on mathematical analysis, Ngonghala et al. (2020) concluded that the widespread use of facemasks (including cloth masks) among people is an effective way to prevent the spread of COVID-19 infections, as long as a sufficiently large proportion of people wear masks. In addition, they noted that it would be possible to eliminate the entire pandemic by combining the use of facemasks with other means of protection such as maintaining social distance (Ngonghala et al. 2020).

Abaluck et al. (2020) investigated the beneficial effects of facemasks by examining the daily increase in infection rates in different countries based on data found in the Israeli disease database. In countries with a longer tradition of facemask usage, before the epidemic broke out, the average daily increase of infection rate was only 10%, while in

[§§] Preprint, not yet peer-reviewed 31.12.2020

countries lacking this tradition, the number of infections increased daily by as much as by 18% (Abaluck et al. 2020). The explanatory factor for the difference seems to be the existence of tradition of mask usage, because also in mortality statistics, the tradition of mask usage is a statistically significant factor even if other factors influencing mortality such as population density, etc. are taken into account (see Cheng et al. 2020). In terms of mortality, Abaluck et al. (2020) found that in countries with a strong tradition of mask usage, the daily growth rate of mortality was 11%, while in countries that did not use facemasks, 21%.

3. Medical disadvantages and risks of facemasks

The next assessment of the problems of facemasks starts with the problems of all types of facemasks, and then moves towards those problems that are only related to cloth masks. This chapter also provides suggestions for each of these problems, on how the problem can be avoided or to what extent more research information is needed.

3.1. Bad fit and air leakage

The worse the mask fits on the wearer's face, the greater the amount of breathing air passing past the edges of the mask as a leakage flow. This problem applies in particular to FFP and N95 respirators, which lack a fitting mechanism that would fit the respirator to faces other than the "average face" (children, for example). An FFP or N95 respirator, which does not fit the face, offers a low level of protection for its user. The Finnish National Institute of Occupational Health (FIOH) recommends that various types of masks should be available for occupational use. Problems of leakage are amplified if users do not know how to use the mask properly (cf. ECDC 2020, 3) or if spectacles prevent the mask from sealing properly on the face. To avoid this problem, the use of respirators should be practiced, and the user should do a fit test before starting to use the respirator (FIOH 2016). If the bad fit is caused by the incompatibility of the respirator and the face, one should change the respirator for another model or for a surgical mask or a cloth mask.

3.2. Discomfort, headaches and allergies

Respirators cause breathing resistance, which in turn could possibly cause a lack of oxygen or harmful accumulation of carbon dioxide in long-term use (e.g. Blaylock 2020).

In order to measure the relevance of this problem, Beder et al (2020) measured the oxygen saturation of 53 surgeons from the fingertips before and after the procedure, with or without a surgical mask. Mask users were found to have a statistically lower median oxygen saturation value after procedures lasting 1 to 4 hours. The clearest difference was found after more than 2 hours. However, even after small procedures lasting less than 30 minutes without a mask, a statistically significant reduction in oxygen saturation was observed. This suggests that the decrease is due in part to stress and in part to the use of a surgical mask. All median oxygen saturation values remained

between 96 and 98%, i.e., above the oxygen saturation reference value of 96%. This reduction of oxygen saturation due to surgical mask usage is at roughly the same level as the oxygen saturation during 3–7-hour long flights (Lee 2002; Geertsema, Williams and Dzendrowskyj 2008; Humphreys et al. 2005).

Multilayered cloth masks and microfiber masks have a relatively high filtration efficiency, but their usage may reduce oxygen saturation or lead to mild forms of hypoxia. This should be taken into account, when comparing alternative facemask types.

Zhu et al (2014) compared the subjective experiences of discomfort among 87 healthcare workers who were using surgical masks or N95 respirators. The discomfort with both mask types increased over time, but the N95 mask was found to be more uncomfortable than the surgical mask at all moments of time between 0.5 and 3.5 h. In addition, N95 masks caused an increase in nasal respiratory resistance due to physiological changes. Subjects did not recover from these changes even after 1.5 h of discontinuation of respirator usage. Zhu et al did not report any other adverse effects for surgical masks.

Ong et al. (2020) performed a survey of 158 health care workers who worked during the COVID-19 pandemic using a N95 masks and a visor. Out of the respondents 85% suffered from a headache after respirator usage. Among them, 81% reported headaches the beginning of the headache in less than an hour of donning the mask, and 88% reported headache the ending of headache after less than half an hour after disarming of the mask. Most subjects felt the headache was mild (72%). Tendency to have headaches before (even without a mask) and wearing the mask for more than 4 hours during the day increased the likelihood of respirator related headaches. On average, the respirator was worn for 5.9 hours per day.

Based on these studies, N95 and FFP2/FFP3 respirators cause significantly more adverse effects than surgical masks. These effects are partly caused by the higher breathing resistance and partly by the tense strings of the respirators, compared to surgical masks.

The risk of allergic reactions relates mostly to colored facemasks that may emit colors to breathed air, unless the fabric has been designed to be worn in front of mouth and nose. The WHO (2019) did not consider the risk of allergies significant, but this may be caused by the fact that the WHO report focused on the use of surgical masks, not cloth masks.

In general, the risk of discomfort and headaches is a factor that may reduce the willingness of the population to use masks, or to use them properly, covering both the mouth and the nose.

3.3. Improper mask usage and increased risk of contagion

The earliest observations of improper mask usage come from Kellogg and MacMillan (1920), who observed American users of masks during the Spanish disease (H1N1) epidemic that began in 1918. According to them, many of the mask users misused the

mask, meaning they only protected their mouths but not their noses, or frequently removed the mask, for example, in order to smoke. People also wore masks only in public places, but not when they met their friends indoors.

According to Kellogg and MacMillan (1920), the users of facemasks may also experience a false sense of security due to facemasks, leading to reduced motivation for other protection methods (e.g. hand washing) or to increased risky behaviors (e.g. crowding). This hypothesis was repeated by FDA year 2006, without references to scientific research (Institute of Medicine 2006, 5). There is also some contrasting evidence against this hypothesis. For example, according to Aiello et al. (2012) people tend to use hand hygiene and facemasks as complementary protective practices, not as alternatives (Aiello et al. 2012). It may also be that proper facemask usage depends on the persistency of authorities in reminding of people of proper use of non-pharmaceutical interventions, before the proper manners become dominant in the local culture (see 5.9). If this is the case, focus should be put to proper training of people, not on argumentation against facemasks.

Another argument that relates to improper usage of facemasks is the idea that facemasks may increase the transmission of pathogens to the user's face, as mask users may touch their face, for example to improve the position of the mask. This argument has been distributed, for example, by ECDC (2020b, 3) and by the U.S. Surgeon General Jerome Adams, which however, did not give any scientific reference to support this hypothesis. Lucas, Mustain & Goldsby (2019) performed an experiment in which they measured how often their test subjects touched their faces when using a mask, and when not using a mask. Frequency for face touching was found to be 5.4 times per hour while using a facemask, and 20 times per hour without a facemask. Thus, the use of a mask seems to reduce facial contact, not to increase it. Also, Chen, Qin, Chen et al. (2020) reported that the use of masks to reduced facial touching in their study.

According to Blaylock, a facemask may worsen the condition of a COVID-19 patient by accumulating SARS-CoV-2 viruses to the air in nasal passages. According to his theory, this accumulation could then induce the transmission of the virus to the brain via olfactory nerves, causing severe symptoms and damage there (Blaylock 2020). However, air exhaled by a COVID-19 patient already contains viruses that go through the nasal passages when the mask user exhales. Blaylock's argument does not illustrate the mechanic causality that would lead to the accumulation of virus concentration in front of face, inside the mask. Due to the lack of a mechanic model and lack of empirical evidence of such adverse effects of facemasks, Blaylock's theory remains a speculative curiosity, which has not gained support among physicians.[***]

[***] For example, according to associate professor Sarah Stanley from the University of California, "Breathing out the virus is not going to appreciably change the amount that is there" [inside the nasal tissue]. "Therefore, there should be no reason why wearing a mask would increase your chance of infection in the brain." (Stanley 2020).

3.4. Disadvantages that relate only to some people

People with respiratory diseases such as asthma have impaired breathing ability. This means that they respirators and facemasks that have a high breathing resistance. This problem can be solved by encouraging people to test different surgical and cloth masks, and then choosing suits them best. Visors can also be an anti-infective solution as they prevent larger droplets from passing from the visor wearer to other nearby people and vice versa. However, they could produce a false sense of security, as newer studies indicate that the main form of contagion of COVID-19 is via air and aerosols, not via bigger droplets (see chapter 2.1).

Children may find it difficult to use facemasks and it may be difficult to instruct children not to touch their when using a facemask (ECDC 2020b, 3). The study of Teunis and Sabel (2008) gives tentative support for this hypothesis, as it showed that the protective effect of facemasks is slightly bigger for adults than for children. On the other hand, according Esposito and Principi (2020), children can be taught to the proper use of facemasks. In situations, in which evidence of the benefits and harms of an intervention are only very tentative, it is important to compare properly the alternatives "intervention" (e.g. mask usage) and "no intervention" (see chapter 5.5). Authorities should not simply assume, based on cultural prejudices, that children cannot use masks properly.

3.5. Problems relating specifically to cloth masks

According to Spooner (1967), a central problem with cloth masks is the loss of their filtering ability within 30–90 minutes of initiation. This problem, however, can be eliminated by acquiring a sufficient number of cloth masks per user, and then changing them every 90 minutes (Spooner 1967).

The most influential arguments against cloth masks, on the 21st century, have been summarized by ECDC (2020b, 2), according to which

> *"There is no evidence that non-medical face masks or other face covers are an effective means of respiratory protection for the wearer of the mask. Overall, various non-medical face masks were shown to have very low filter efficiency (2–38%). In one study, cotton surgical masks were associated with a higher risk of penetration of microorganisms and ILI compared to no masks."*

The conclusion of the low filtering efficiency of non-medical facemasks was presented with reference to Rengasamy, Eimer and Shaffer (2010), which summarized the results by stating that cloth masks filtered 10–60% of the polydisperse NaCl aerosols and 8–91%. ECDC failed to recognize that some fabrics and masks had a filtering capacity as high as 60%, and that several other studies of the filtering efficiency of facemasks had been published after 2010 (see chapter 2.3). Due to these problems, the conclusion of ECDC of the very low filtering capacity of facemasks is biased. It also ignores the fact

that reduction of viral load by 30–60% may be enough to prevent the COVID-19 disease, although it may not be sufficient to prevent some viruses from entering the respiratory system of the mask wearer (see chapter 2.1).

The note of ECDC about the higher risk of ILI was based on MacIntyre et al. (2015). In this study, MacIntyre et al. investigated the difference between surgical masks and cloth masks in their ability to protect healthcare workers from viral infections. Test subjects, who were healthcare workers, working in hospital, were randomly divided to three groups or "arms". The members of the first group received five cloth masks per person, and were instructed to change mask every 90 minutes. The members of the second group were advised to use diligently a surgical mask all the time. A third group was called "the control arm" and was instructed to continue their traditional ways of working, which included the usage of surgical masks, based on own judgement.

The biggest problem of the study of was its lack of a real control group of test subjects, who would have not used any facemask at all. Due to this deficiency, one cannot use the study for making any scientifically valid comparisons of "cloth mask usage" versus "not using any mask at all". Despite the lack of a proper control group, MacIntyre et al. concluded that:

> *"The finding of a much higher rate of infection in the cloth mask arm could be interpreted as harm caused by cloth masks, efficacy of medical masks or most likely a combination of both."*

The conclusion of the *harm caused by cloth masks* is scientifically invalid, as it is not possible to make a conclusion without a proper control group consisting of persons who do not wear any facemask at all. This careless conclusion may be partly caused by the close connections of the investigators to 3M, which was a manufacturer of respirators and surgical masks, year 2015, but not a manufacturer of cloth masks (see MacIntyre et al 2015, 9). The research and observation reporting process of MacIntyre et al.

In addition to this fundamental flaw, the reporting of the observations was severely biased. The effect of surgical mask usage and cloth mask usage was studied with two explanatory variables, *ILI attack rate* and *CRI attack rate*. ILI refers to influenza-like illnesses that are characterized by at least one respiratory symptom and in addition a fever of at least 38 degrees Celsius. CRI means a clinical respiratory disease with at least 2 respiratory symptoms but no more than 38 °C of fever. Test subjects were healthcare workers. The data of MacIntyre et al. showed that among subjects, who used cloth masks, the incidence of ILI (attack rate) was 13.25 times higher than in the group that used surgical masks, and the incidence of CRI was 1.6 times higher (see Appendix table 2). However, MacIntyre et al. reported only the ILI attack rate, giving the impression that the cloth masks users have over *13 times higher chance of being infected* than the users of surgical masks. A more scientific conclusion would have been to state that cloth mask usage was connected with 1.6–13.25 times bigger risk of respiratory infections, or to count together ILI and CRI attack rates to get a bigger sample.

Another problem in the reporting of results was that MacIntyre et al. claimed that different groups of test subjects resembled each other demographically. However, this was an exaggeration. The comparison of the users of surgical masks with the users of cloth masks reveals that the users of cloth masks had more risk factors such as less frequent daily hand washing, higher number of daily patient contacts, and previous illnesses (see Appendix table 3).

MacIntyre et al. did not report year 2015 whether subjects of the study had followed the instructions for changing and washing their cloth masks. Instead, MacIntyre and al. raised general and unspecified concerns that users of cloth masks may not follow instructions for frequent mask changes or proper washing. This means that the higher ILI attack rate of the fabric mask group may have been partly due to the prolonged use of the same masks. An article of MacIntyre & Chungantai (2020) supports this interpretation and adds *bad material* of the cloth masks as a possible explanation to the higher ILI and CRI attack rates.††† This means that the bad materials and bad instructions to mask users may have caused the lower protective efficiency of cloth masks. This means that very different results may have been received in a study made with better quality cloth masks (see 2.3) and with better instructions about how to use them and to clean them (see 4.3).

In summary, the conclusions against cloth masks have been proven exaggerated or fallacious. Yet, influential international institutions like ECDC and the U.S. Surgeon General have distributed them. The reasons for the spreading of these arguments have been analyzed in more detail in chapters 5 and 6.

4. Economic and ecological effects of facemask usage on population level

Some of the disadvantages associated with facemasks are economic or ecological in nature. This chapter discusses the economic benefits of facemasks, which have so far been covered in the Finnish media. After the economic benefits, the ecological problems caused by the masks are addressed and finally it is investigated whether the economic and ecological problems could be minimized by means of fabric masks.

4.1. Economic benefits

In their study, Abaluck et al found that in countries with a long tradition of using facemasks, even before the epidemic broke out, the average daily rate of infection was only 10%, while in countries lacking a tradition of using facemasks, the number of infections increased daily by as much as 18%. The daily increase in mortality was 11%

††† "The material, design and adequacy of washing of cloth masks may have been a factor" (MacIntyre and Chungantai 2020). The report of MacIntyre et al. 2015 has been criticized also by researchers of medicine (e.g. Terry 2020)

in countries that used facemasks and 21% in other countries (Abaluck et al. 2020 see chapter 2.5 for more details).

Abaluck et al. converted these mortality rates into monetary losses (2020) using Greenstone's and Nigam's (2020) estimate of $ 60,000 per loss of a life. The total monetary loss to the nation can then be reduced by lowering the R0 value of the SARS-CoV-2 virus. Ferguson et al (2020) have calculated that a 10% reduction in the R0 value will reduce the total mortality of the population by 10%. Based on this calculation, Abaluck et al concluded that the wide usage of facemasks by the population will reduce the costs of the epidemic by 6.000 $ per citizen. If this estimate is applied to USA, the economic benefit of wide mask usage would be roughly 2000 billion dollars, and in Finland, the benefit would be about 28 billion euros.

The reduction to the number of lost lives could be even bigger than 10%, if we take into account the hypothesis that lowered virus load will lead to lowered severity of the disease. For example, in the Diamond Princess, where passengers did not use facemasks, 80% of the infected persons developed symptoms (Mizumoto et al 2020), while in the Ernest Shackleton, were mask usage was obligatory after the first diagnosed cases, only 20% of infected persons developed symptoms (Ing, Cocks & Green 2020). Mask usage may also cause other financial benefits than the ones estimated by Abaluck et al. The usage of facemasks will probably also reduce the amount of other respiratory infections. Because other respiratory infections may have the same symptoms as COVID-19, every sick person should be treated as if they had coronavirus disease. Thus, a reduction in suspected cases would also save health care resources and costs, as well as other disadvantages caused by respiratory infections, in addition to the actual reduction in COVID-19 cases. The benefit would be particularly significant in the winter, when influenza, RS virus (RSV), common flu, and COVID-19 may co-occur simultaneously.

4.2. Economic and ecological cost of single-use masks

The respirators and fiber cloth masks are disposable, unless sufficiently reliable methods can be developed to disinfect the masks while ensuring that the filtering efficiency of the mask is maintained at least close to pre-disinfection level. Disposable masks cause economic costs as well as ecological disadvantages: If a person uses four facemasks per day for 5400 days, the total consumption is then 1600 masks per person. This would create a cost of 800 $ per person, assuming the cost of 0.50 $/mask. Applied to the US population, this would mean a cost of roughly 200 billion dollars. Although this cost is only about 10% of the estimated benefits of systematic population level facemask usage, there is a need to reduce the costs, as 800 $ per person is probably too much for some families.

One way for reducing the costs is to recommend facemask usage only to public transportation and to other public spaces, were sufficient safety distances and ventilation cannot be guaranteed. This could possibly reduce the need for facemasks by 50%. Another solution is the reuse of fiber cloth masks. For example, according to

Harlin, Salo & Kulmala (2020), fiber cloth masks can be washed approximately 10 times before their filtration capacity will be significantly reduced. This would reduce the consumption of facemasks by 90%. By combining these methods, the costs of facemask usage could be reduced from 800 $ per person to roughly 40 $ per person, during a period of 400 days, if we assume that the washing of facemasks is done without an extra cost, as part of the family's regular laundry routine.

In hospitals and other locations of big facemask consumption, a potential cleansing method is also steaming the masks with hydrogen peroxide (Laatikainen et al 2020).

One more method for disinfecting facemasks is putting the used mask on quarantine, as the SARS-CoV-2 virus is relatively fragile and does not survive on surfaces more than a few days in a contagious form. Yet, the quarantine is still an experimental method of disinfection and more research is needed before it can be recommended more widely. As the quarantine of masks requires planning, organization and bookkeeping, it is probably more suitable for the more expensive masks like N95 and FFP/FFP3 masks, than for the surgical masks.

4.3. Solving the economic and ecological problems with cloth masks

Woven and knitted fabric masks are washable and there is no need to limit the number of washes. Therefore, they could be an ecologically and economically good solution to the problems of disposable facemasks. When deciding, what kind of a cloth masks to use, it is necessary to consider four factors:

1. Filtering efficiency
2. Breathing resistance
3. Fit (to avoid air leakage)
4. Resistance of colors

The filtering efficiency of masks is improved, when more layers of cloth are added (e.g. Konda et al. 2020). This, however, is a limited strategy as the improved filtering efficiency is gained at the cost of increased breathing resistance. High breathing resistance will lead to high discomfort, and therefore, multi-layered cloth masks are suitable only to special occasions. This is also applicable to microfiber masks, at least to some extent. However, if the additional layers are made of tissue paper, it will not increase the breathing resistance too much.

The best cotton-polyester facemasks have the filtering efficiency of 60% – 75% against particles ranging in size from 0.02 to 3 micrometers. These cotton polyester mixtures also have a lower breathing resistance than most double layer cotton masks (see chapter 2.3). One way for increasing the filtration efficiency of cloth masks is to add a layer of tissue paper on top, to the outer surface. According to the Hong Kong Consumer Agency, their filtration capacity of such a facemask will be about 90% of the filtration capacity of surgical masks (Consumer Council of Hong Kong 2020). It seems, however, that additional research would be needed to confirm these conclusions.

The advantage of knitted fabrics would be that they are flexible, i.e., they usually fit better on the wearer's face than woven cloth masks. As a result, they let fewer aerosol particles past the edges of the mask. The disadvantage of knitted masks is their poorer filtration efficiency, as the loops of the knit form openings and can be larger than the gaps between adjacent yarns of the woven fabric. Although knitted masks, in general, have a closer fit than woven masks, it is probably possible to improve the fit of woven masks by proper design (see Morishima and Mitsuno 2019, 4670–4680).

According to CDC, you can disinfect a cloth mask by washing it in a machine with other laundry (CDC 2020b). This instruction does not contain a note of a higher-than-normal temperature, because detergent alone is a sufficient method for breaking the lipid envelope of the virus (Kampf et al. 2020). In order to assure the disinfection, the washing should last at least 15 minutes (Chin et al. (2020).

The resistance of colors against washing and friction is important as some colored fabrics release color particles that can enter the flow of inhaled air. Not all fabrics are suitable to be worn in front of the mouth and nose. The emittance of colors can be induced by the humidification of the fabric and by facial movements. The amount of color that is emitted can be tested with standardized tests concerning the resistance of colors against water, washing and friction. If the provider of cloth masks or the selected fabric has not provided information about the resistance of the colors, it is better to select an uncolored alternative. The selection of uncolored masks is supported also by the fact that the disinfection of cloth masks can be improved with bleach (CDC 2020b). Out of the colored alternatives, only cotton masks, colored with vat dyes, can be bleached, and the bleaching method is then limited only to chloride.

If you compare masks of the same breathing resistance to each other, the polyester and polypropylene masks are likely to have the best filtration capacity because of their electrical charge, which causes airborne particles to adhere more effectively to the mask. Polyester and polypropylene masks, however, should not be treated with a fabric softener, as they tend to remove the electricity of the fabric, at least to some extent.

From the above comparison, it seems that the most preferred solution for fabric masks are woven masks made of polyester, polypropylene, or a blend of cotton and the polyester/polypropylene, as these masks have a relatively low breathing resistance and still moderate filtration efficiency. For example, with a blended fabric with 70% cotton and 30% polyester, it is possible to achieve a 60% filtration efficiency (chapter 2.3).

5. Cultural, political and bureaucratic discourses against facemasks

5.1. Background

In April 2020, the majority of European countries either recommended or required the use of facemasks in public places or on public transport. Only the Nordic countries, Ireland, England and the Netherlands had not issued a recommendation concerning mask usage, suggesting that also asymptomatic citizens should wear facemasks (YLE 2020-04-16). At the end of May, only the Nordic countries refrained from recommending the use of facemasks (STM 2020b).

In Finland, the ministry of social affairs and health (STM) decided in April 2020 not to recommend facemasks to citizens, and this decision was later in June supported by a consultant's report, according to which the benefits of facemasks are "*minor or non-existent*" (STM 2020b, Abstract).

The objective of this chapter 5 is to assess the historical, cultural, administrative and political reasons that led to Finland's facemask sceptic guidelines (STM 2020a), and the (quasi) scientific discourses that led to the consultant's reports that perceived facemasks as useless for wider public usage (STM 2020b). This objective is approached from the point of view of administrative sciences, sociology and cultural studies, using memetic discourse analysis as a central theory and method.

5.2. Theory and method of memetic discourse analysis

The selected theory and method for analyzing facemask related scientific, administrative and non-professional beliefs, was *memetic discourse analysis* (Malmi 2009), which is based on the fusion of memetics (Dawkins 1976, Malmi 1988/1992/2009) and intertextual discourse analysis (Fairclough 1992). According to this theory and method, culture and knowledge appear in the form of discourses and memes that mutate, evolve and degenerate continuously. Similar approaches have been used in different fields in order to study, for example, the following topics:

- Meanings, messages and stories that are carried by languages (Harris 1951)
- Rules and social norms that are carried by discourses (Foucault 1970)
- Evolution of scientific innovations (Kuhn 1971, Popper 1972, Lakatos 1978)
- Evolution of knowledge within AI systems (Shank and Abelson 1977)
- Evolution of innovations, methods and competences (Nelson and Winter 1982; Aldrich and McKelvey 1983)
- Preservation and change of social constructions (Habermas 1984).
- Connection of discourses to each other (Fairclough 1992).
- Connection of arguments to each other and argument mining (e.g. Moens 2018)

Sociologists and philosophers of science have tended to analyze larger knowledge structures like ideologies, discourses, paradigms and research programs. Administrative sciences, economics, argument mining, and memetics, however, focus more on smaller units of knowledge. According to Dawkins (1976), the focus on small units of knowledge and information is necessary, as the cognitive and communicative limits of humans tend to break all bigger structures to smaller pieces. Dawkins calls these smaller pieces *memes* (Dawkins 1976) whereas in discourse analysis they are called *discursive elements* (e.g. Habermas 1984). Even the larger knowledge structures can be perceived as constellations of interrelated memes (Malmi 2009, 89–92).

Paradigms are rigid discourses that intend to explain what really exists in the world that we observe. They actively repel observations, interpretations and statements that are not compatible with the core memes of the paradigm. Ideologies are discourses that not only interpret, how the world is, but also focus on stating, how the world should be. It is possible to perceive ideologies, discourses and paradigms as cultural interactors that go through their own evolution by changing their memes, exchanging memes and making alliances with other discourses, and by creating ad-hoc adjustments to their peripheral memes, when under attack (see Popper 1972, Lakatos 1978, Hull 1982, and Malmi 2009). In the intertextual discourse analysis, an emerging consensus is that both smaller and bigger elements of text need to be studied to understand, how texts may transform social and historical resources, how texts may 're-accentuate' genres, and how genres (discourses, narratives, registers) may be mixed in texts (Fairclough 1992, 195).

Discourses and memes can appear in symbolic form (e.g. in texts), in material form (e.g. tools, decorations, buildings) and in performative form (e.g. spoken stories, songs, rituals and performances). The evolution and degeneration of knowledge is possible even without texts and symbols, based on the manifestation of memes on objects and based on the performative representations that carry knowledge from generation to another.

Discourses are not objective structures of knowledge. They can also yield power, persuade, or belittle some parts of their audience. To conceptualize this characteristic of discourses, the sociologists have developed the term *subject position*. It refers to the role that a user of the discourse takes, or to roles that a discourse offers or even imposes on certain actors mentioned in the discourse (Davies and Harre 1990, 48; Törrönen 2001). For example, the STM (2020b) report of facemasks offered citizens two alternative subject positions: The position of a *healthcare worker*, which was connected to the recommendation to use facemasks, and the position of *non-professionals,* connected to the implicit recommendation of not using facemasks.

A key methodological and theoretical question in the study of discourses and memes is the question: Are these two memes (or discourses) the same or different? In the study of artificial intelligence and linguistics, two phrases are considered instances of the same *paraphrase*, if the meaning of both phrases is the same, even if the wording or language of the phrase is different (Shank & Abelson 1977). In the study of history, the

question of sameness appears in the question: Are these two narratives the same, or different? (Kuukkanen 2015).

The early scholars of memetic cultural evolution (Dawkins 1976, Nelson and Winter 1982; Aldrich & McKelvey 1983) perceived human culture as relatively panmictic, meaning that memes would freely flow from people to people. This idea is a simplification, and is not compatible with the study of human communication networks (e.g. Rogers & Rogers 1976). In order to understand the evolution and degeneration of human knowledge, it is necessary to identify the actors that have a central gatekeeper, liaison, influencer or information distributor position in the communication network, and to visualize what kinds of mutation and selection processes happen in the communication between the actors.

To meet this objective, a general model of the degeneration of scientific information is presented in Figure 3, in which the processes of degeneration are shown with orange, and the corrective processes with green arrows. Blue arrows represent processes that may either improve or degenerate information. The starting point of this degeneration are the scientific observations which are supposed to be objective, but which are not, due to the paradigms and principles, and other discourses and memes that may cause bias to the selection, interpretation and presentation of observations. The observations are summarized to thousands of reports and articles. Due to the limits of human information management capacity, public authorities will only review, select and utilize a small subset of all research reports. The green boxes represent actors, and the orange boxes represent information that is distributed to citizens by authorities.

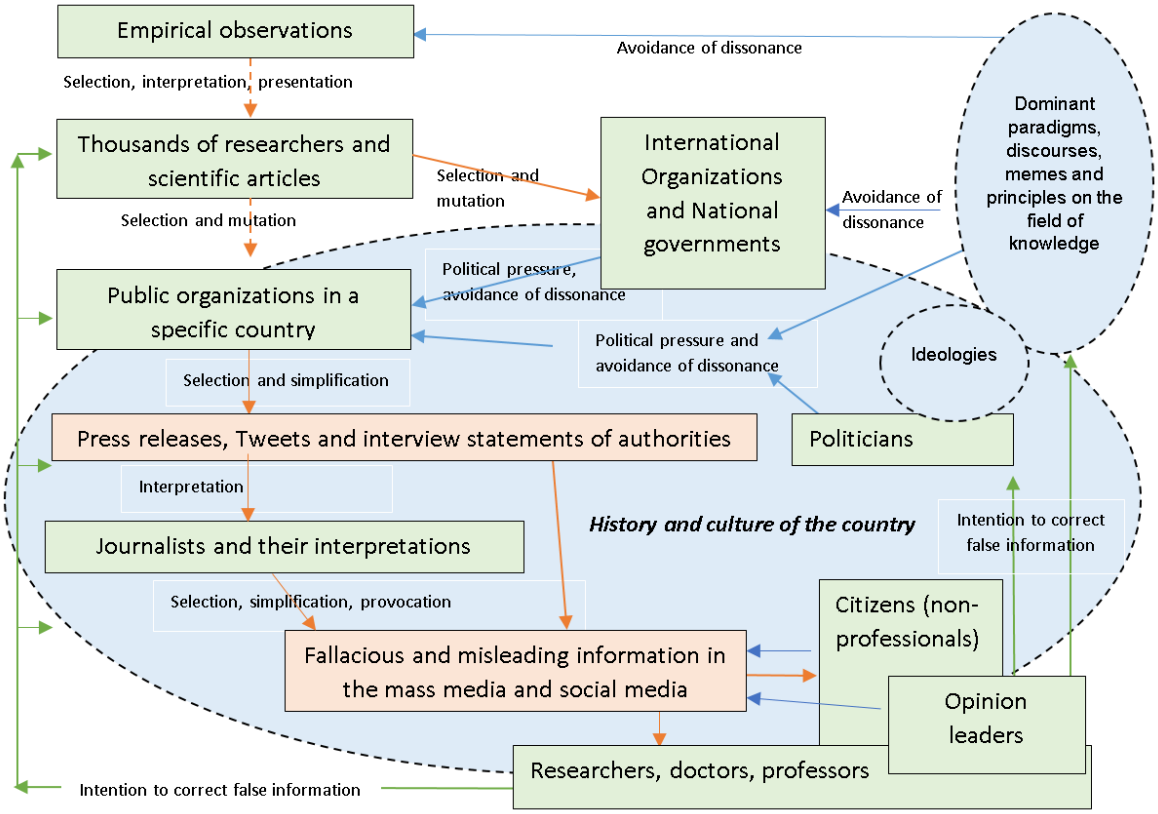

Figure 3: The degeneration of scientific knowledge in modern societies

When employees of the public organization read, interpret, and copy scientific statements, the processes of *mutation* start changing the content of the memes. It is common that complicated and boring parts like assumptions, disclaimers and detailed references are omitted. Authorities also intentionally simplify messages, leaving out the complicated parts, exaggerating the messages a bit to make them more attractive: The processes of selection, simplification and mutation are steered and amplified by the dominant paradigms and discourses, which actively repel information and knowledge that is not compatible, and interpret evidence in manners that fit the paradigm. This avoidance of incompatible information can be explained by dissonance theory (Festinger 1957), according to which people in general avoid information that is contrary to their beliefs. One form of avoiding dissonance is the need for organizations to maintain their memes compatible with their parent and peer organizations.

As public organizations, even specialized expert organizations, are connected to the political government of each country, they are not purely scientific but instead, influenced by the dominant political decisions, arguments, discourses and ideologies. It is even possible that in some instances the government pressures public expert organizations to hide "worrying" information from the citizens, or to distribute false or misleading statements. In addition, the history and general culture of the country have an effect on all decisions and conclusions that public authorities make. This may lead to different local interpretations of the memes and discourses, although the origin of these memes and discourses may have been international and scientific.

The more steps there are in communication, the more likely it is that simple memes will replace their more complicated memes. This basic rule applies also to instances, in which the simple meme is fallacious, and the complicated meme is scientifically much more valid. The logic of media and social media favors *provocative* and simple memes, which are easily copied via the Internet, for example, in the social media.

When focusing on the role of public organizations, we need to note that many public organizations prefer to quote other authorities and only to lesser extent scientists. This tendency means that authorities may frequently apply "argument of popularity", basing their decision primarily on the opinions of other authorities, and only secondarily on scientific evidence. Another probable tendency of authorities is to argue from their position of authority, without giving references to scientific studies. A third tendency of organizational decision makers is to base their decisions on simple rules of thumb (March & Olsen 1972).

According to philosophy of science, it is the task of scientists to do their best to minimize the mutation, oversimplification, misinterpretation and miscommunication of scientific knowledge. Yet, the career incentives of scientists do not encourage scientists to allocate their time to correcting false statements that are circulated by public authorities, media, politicians or citizens.

The theoretical model above was mostly provided without any empirical references that would support it, as it is the task of empirical research to evaluate, whether the empirical observations support the model or not.

Method

The method of the study was a hermeneutic case study, which focused on discourses and memes that were carried and distributed by social interactors like persons and organizations. The focus of the case study were facemask related memes and discourses that took effect in Finland, but it was soon found that these discourses and memes mostly originated from international sources.

The first step in the study of facemask related memes and discourses was to identify the social influencers that have probably had an impact on the decision-making and communication of STM and THL in Finland. These actors were found to be the World Health Organization (WHO) and the European Center for Disease Prevention and Control (ECDC). At a later phase of the study, also some other influencers were identified, such as the CDC, and also FDA, and Sweden's state epidemiologist Anders Tegnell to a lesser extent. The identification of central organizations and influencers made it possible to tailor the general model of the degeneration of scientific information (Figure 3), to the context of COVID-19, facemasks and healthcare sector. This tailored communication network is shown in Figure 4.

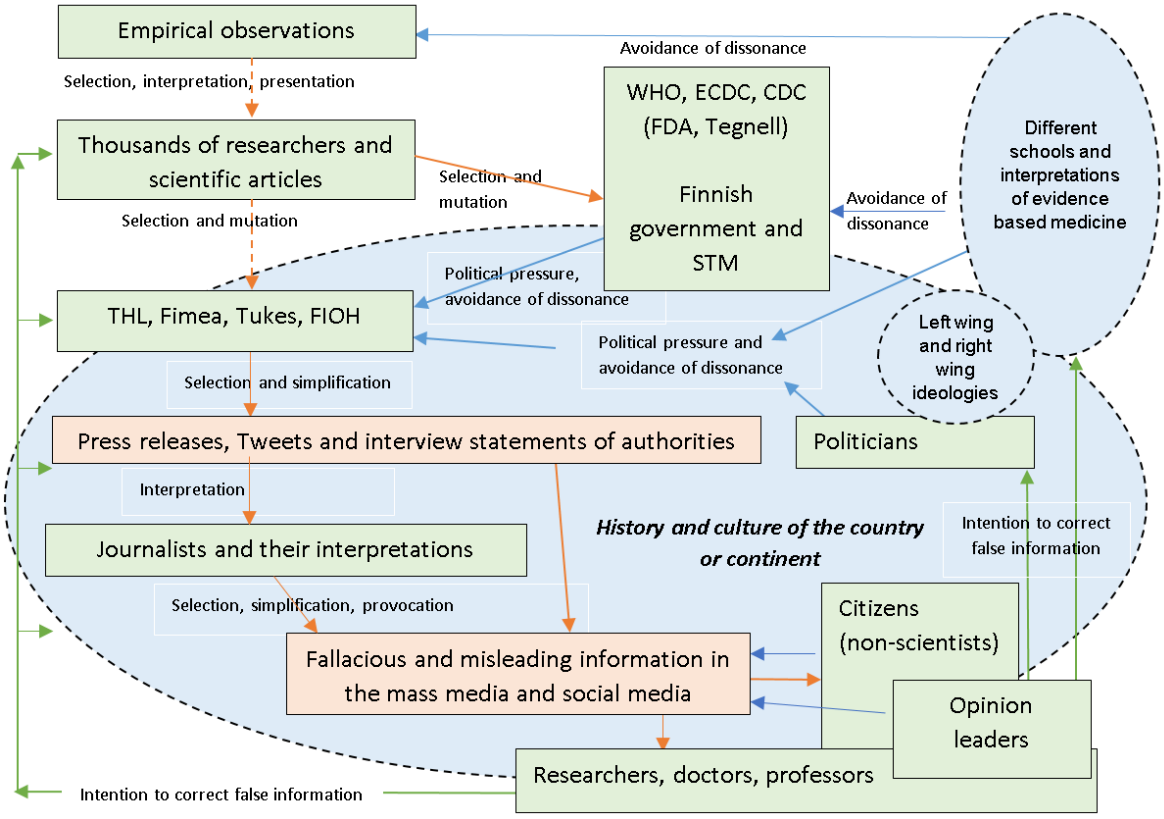

Figure 4: The flow of facemask memes in the network of scientists, authorities, politicians and citizens

The central Finnish organization that participated to the distribution of influential facemask related press releases and interview statements were found to be the

- Finnish ministry of social affairs and health (STM), which coordinates health topics on the political level.
- Finnish Institute for health and welfare (THL), which coordinates the collection and distribution of healthcare related information (STM 2012).
- Finnish Safety and Chemicals Agency (Tukes), which is responsible, for example, for the quality control of protective equipment.
- Finnish Medicines Agency (Fimea), responsible for the safety of pharmaceutical interventions
- Finnish Institute for Occupational Health (FIOH), responsible for the safety of the employees of private and public organizations.

After identifying the central actors in public administration, the focus of the study moved to facemask related decisions, press releases and interviews of public authorities, and to the media interpretations of these texts and statements.

The study advanced hermeneutically in spirals of understanding. After central actors, press releases, interviews, discourses and memes had been identified, the understanding of the topic was extended by adding more actors and texts to the scope of study, to clarify the picture and to find more evidence of the actual connection of mask-sceptic arguments to wider scientific, administrative, political and cultural discourses.

5.3. Central events, press releases and reports

Facemasks were a debated topic generally in the world, as is shown by the quick changes in the opinions and statements of WHO, CDC, and European countries in this topic (see chapter 70). In Finland 2020, the points of culmination in this debate were the following events and texts:

April 3rd, FIOH, Fimea and Tukes give a press release with a headline "*Self-made mask does not protect from the corona virus*" (FIOH 2020). The press release also claimed that self-made masks could become "*virus spreaders*" unless they are properly worn and cleaned. A third mask-sceptic meme was the statement, according to which "*The best ways to protect oneself against the coronavirus is to stay home, keep a safety distance of 1–2 meters and to wash hands frequently*" (FIOH 2020). This statement means that, according to the press release, hand washing and safety distances are both more effective means for protecting oneself against COVID-19 than facemasks. All of these statements were presented without any reference to scientific evidence.

Media headlines amplified the mask sceptic message of the press release of FIOH by emphasizing that "*a self-made mask can actually spread the virus*" (e.g. Demokraatti 2020-04-03).

April 14th the general director Markku Tervahauta of THL stated, "*There is a risk that we will run out of surgical masks and therefore, they should be reserved for healthcare workers*". On this basis, Tervahauta recommended that all citizens should consider wearing cloth masks (Tervahauta 2020-02-14). Tervahauta's statement was immediately questioned and challenged by Kirsi Varhila, the chief executive of the Ministry of social affairs and health (STM). She stated that Tervahauta had spoken only as a private person.

April 18th STM and THL confirmed that Finland's official policy is that STM and THL do not issue a recommendation for people to wear cloth masks (STM 2020a). Already on the same day media concluded that "*according to STM the facemask does not protect its user from the corona virus*" and that "*a self-made mask can, in the worst case, increase the risk of the virus infection*" (Kaleva 2020-04-18).

Beginning of May, some schools prohibit facemask usage from their teachers, based on the decision of STM not to recommend facemask usage (YLE 2020-05-12).

May 11th the union of municipal employers published instructions to schools about how to avoid the COVID-19 epidemic (KT 2020). These instructions stated, "Schools are not obliged to prohibit facemask usage from their teachers".

May 29th, STM published a consultant's study according to which the benefits of facemasks are "*minor or non-existent*" (STM 2020b, Abstract).

August 2020 the Finnish grocery store chain S-ryhmä prohibited facemasks from their employees. S-ryhmä based their decision on the instruction of authorities, according to which facemasks could be dangerous unless the employer closely monitors mask usage (Koskinen 2020-08-15).

The objective of the next chapters is to analyze, what memes, discourses and ideologies might have had an effect on this flow of actions, which seems to have converted the scientific knowledge of facemasks (see chapters 2–3) to unscientific and badly justified decisions of some Finnish schools and grocery stores. This study will start from the often-repeated argumentations, and then advance to the discourses and ideologies that have probably had an effect on the popularity of these argumentation lines.

5.4. "No proof of benefits" and *"there is a shortage of surgical masks"*

The two memes, presented in the title of this chapter, seem to form the basis of the most influential mask-sceptic line of argumentation. It has been presented e.g. by medical professors Brosseau and Sietsema (2020), U.S. Surgeon General (2020), ECDC (2020b), and STM (2020a and 2020b), and also partially by the WHO (see chapter 6).

According to this argument, there is no basis for mask recommendations because:

1. *The scientific evidence on the benefits of masks is not strong enough.*
2. *Surgical masks are in short supply and should therefore be reserved for use by healthcare professionals.*

Argument 1 is not in line with chapter 2, which presents a large body of scientific evidence about the benefits of facemasks. The rhetoric power of argument 1 is also weakened by argument 2, as is shown below.

Argument 2 can be deconstructed into two interrelated arguments, according to which

> a) Surgical masks are of considerable benefit to healthcare workers in their efforts to minimize their own risk of infection.
>
> b) Surgical masks should therefore be reserved for healthcare workers.

Although Brosseau and Sietsema partially conceal statement 2a in their own line of argumentation, this statement appears in the second paragraph of the same article, where Brosseau and Sietsema state that there is no statistically significant difference in the level of protection between surgical masks and N95 respirators. In other words, Brosseau and Sietsema believe that surgical masks provide significant protection for healthcare workers against viruses (argument a).

U.S. Surgeon General (2020) presented arguments 1 and 2 in his Twitter message in the following form:

> *"Seriously people – STOP BUYING MASKS! They are NOT effective in preventing general public from catching #Coronavirus, but if healthcare providers can't get them to care for sick patients, it puts them and our communities at risk!"*

In other words, according to the U.S. Surgeon General, people should not wear facemasks because the masks will give them *no benefits*, whereas the facemasks are so *highly beneficial* for doctors and caregivers, that facemasks should be reserved only for healthcare professionals.

This semantic and memetic analysis shows the underlying ethical and moral message of U.S. Surgeon General and Brosseau & Sietsema. According to this message, it is in the best interests of *society* that citizens do not protect themselves with surgical masks, and instead, reserve the masks for the health workers who need those most. This argument may be valid in the reasoning of governments and health authorities, but it is an argumentation line, that has stretched far away from the domain of medicine into the area of politics and ethics. It is not an objective scientific statement, which citizens could use for maximizing their own well-being, or the health of their family.

In Finland, the reasons for not recommending facemasks in spring 2020, and the reasons for changing this recommendation in August 2020, are illustrated by an article published in the Finnish Journal of Medics. According to this article, the greater Helsinki area Hospital (HUS) has started in August 2020 to recommend the use of facemasks as a means for protecting patients in hospitals, as the availability of masks has improved (Lääkärilehti 2020, p. 1345). Thus, HUS already knew the benefits of facemasks in spring 2020, but the masks were not recommended to patients due to the lack of facemasks and due to the wish to reserve the masks for health-care professionals.

This chapter raises the question, whether FIOH, Fimea and Tukes intentionally lied to the public when they claimed that "*hand washing and safety distance of 1–2 meters are the best ways to protect oneself*". The same question of intentional misleading of the public also applies to the facemask report of STM (2020b), which claimed in June 2020 that the benefits of facemasks are "*minor or non-existent*". Based on the memetic discourse analysis, performed in this study, it is unlikely that intentional lying or misleading would have been the primary motives for such statements. A better explanation seems to be found within the *Cochrane paradigm* of evidence-based medicine.

5.5. Cochrane paradigm of evidence-based medicine

Evidence-based medicine originates from the research report of Archie Cochrane (1971), which concluded that about 10% of all medical interventions given to patients have proven to be ineffective based on empirical studies. This started the emergence of a medical tradition, according to which new interventions should not be recommended without strong empirical evidence (Rogers and Hutchison 2017). This new tradition, which considered RCT studies as the best possible evidence, was named evidence-based medicine in the late 1980's and the abbreviation EBM gained popularity in the early 1990's (Straus and McAlister 2000). The increase of the popularity and influence of EBM was based on its intuitively attractive goal, which was the "*appraisal and use of research results in the care of individual patients*". It sounded convincing and scientific, as the earlier paradigm of medical decision-making had been centered mainly on unsystematic clinical observations, reliance on mechanistic reasoning, and on pathophysiological principles about how the body functions and how diseases develop. Clinical practitioners did not follow systematically enough the newest research results of their field, partly because knowledge was still mostly in libraries, and not freely available in medical databases or in the internet. Therefore, there was a new consensus, that more emphasis should be put to the analysis of research results and scientific articles.

The superiority of EBM was challenged in the turn of the 21st century. Critics claimed that EBM has become a rigid "cookbook" medicine, which forces physicians to follow rigid guidelines, focuses almost only on RCT studies, and ignores clinical experience, intuition, and the values of the patient. The proponents of EBM, like Straus and McAlister (2000), claimed that this criticism is only a misunderstanding of EBM, and that the Cochrane Collaboration society has already improved its guidelines and handbooks, based on the criticism (e.g. Cochrane Collaboration 2004 and 2019). Yet, the idea that "errors have already been corrected" shows that the earlier instructions were somehow fallacious or at least somewhat biased. Due to the problems of EBM, the proponents and critics of EBM arranged an "EBM renaissance group workshop" year 2013, and summarized the problems of EBM in the following manner (Table 5, column on the left).

Table 5: The problems of EBM according to Greenhalgh et al. (2014), with explanations

Problems: Greenhalgh et al. 2014	Explanations and examples
"The evidence based "quality mark" has been misappropriated by vested interests"	Ethical problems of vested interests, forgery of results with P-hacking methods, publishing only positive findings, etc. (see Rogers and Hutchison 2017, 9-13).
"The volume of evidence, especially clinical guidelines, has become unmanageable"	The volume of evidence leads to the distancing of the practicing clinician from science (as he will only be reading Cochrane reviews, not research reports).
"Statistically significant benefits may be marginal in clinical practice"	EBM may not produce benefits in clinical practice, it may only give an "aura of professionalism" to medics.
"Inflexible rules and technology driven prompts may produce care that is management driven rather than patient centred"	Rigid following of "cookbook" medicine and algorithms is suitable for beginners, but not for highly experienced professionals. Cochrane paradigm puts EBM, Cochrane reviewers, hospital management and insurance companies on a pedestal and the patient and the practicing clinician are not valued.
"Evidence based guidelines often map poorly to complex multimorbidity"	Real-life situations are more complex than what can be captured with RCT studies.

Based on this problem analysis, Greenhalgh et al. 2014 suggested the following new principles for the "Real evidence based medicine". Again, some explanations are added to Table 6:

Table 6: The principles of the Real Evidence Based Medicine (Greenhalgh et al. 2014) with explanations

The real evidence based medicine	Explanation
Makes the ethical care of the patient its top priority	Patient (or customer) must be permitted to define his or her values and to set the goals and constraings of the intervention.
Demands individualised evidence in a format that clinicians and patients can understand	Less emphasis on massive tables that show P-values. More vivid comparisons of the benefits and risks of the intervention.
Is characterised by expert judgment rather than mechanical rule following	If a proposed process or algorithm is found to be unfeasible, an experienced decision maker may deviate from it.
Shares decisions with patients through meaningful conversations	Patient is engaged from the beginning (and is permitted to define the goals and constraints of intervention).
Builds on a strong clinician-patient relationship and the human aspects of care	The clinician should value the goals set by the patient over professional algorithms and rules of thumb.

Applies these principles at community level for evidence based public health	The customer (population) must set the goals and understand each step of decision-making, and participate to decisions.

When we analyze, what Greenhalgh et al. 2014 criticize and combine it with the complaints of other critics[‡‡‡], we can formulate the "*Cochrane paradigm*" of the EBM as the exaggerated, rigid and misinterpreted version of EBM. We may then define the "*theory of EBM*" as an opponent and rivals of this older paradigm. The difference of the Cochrane paradigm and the theory of EBM appear on two three strategic dimensions:

1. **Time scale:** Cochrane paradigm represents the 20th century while the theory of EBM represents the 21st century.
2. **Essence:** Cochrane paradigm represents EBM in the way it was (mis)interpreted and exercised, whereas the theory of EBM represents how it should be practiced.
3. **Completion:** Cochrane paradigm is a relatively well-manifested and rigid set of beliefs, while the theory of EBM is still something that is under construction, meaning that it can be better characterized as a discourse than a paradigm.

Although we could call the theory of EBM as "Real EBM", this concept might be a bit misleading, as one could claim that "real" means the way in which a theory is applied in the real world. In other words, it would be possible to claim that the Cochrane paradigm is actually the real EBM, and that the "Real EBM" is just a nice dream. Due to this, the term "theory of EBM" is used in the next chapters. Another reason for this naming is the fact that the theory of EBM is something wider than what was coined by Greenhalgh et al. 2014: It also contains a direct connection to the general theory of decision making (e.g. Simon 1957). Table 7, below, presents the Cochrane paradigm and the theory of EBM as two extremes or ideal types. Each row of the table represents one dimension or topic of these competing discourses. The table starts with the *mission* of the discourse and then explains the central *problem perceptions* and *subject positions* handled in the discourse (rows 1–3). Finally, the table shows the practical *instructions* for applying the discourse to different situations:

[‡‡‡] McColl, Smith, White and Field (1998); Hayward, Wilson, Rubin, Bass, Johnston et al. (1994); McAlister, Graham, Karr and Laupacis (1999); Hagdrup, Falshaw, Gray, Carter (1998); Ghali WA, Saitz R, Eskew AH, Lemaire JB, Gupta M, Hershman WY. (1998); Olatunbosun OA, Edouard D. Pierson RA. (1998)

Table 7: Comparison of the Cochrane paradigm with the Theory of EBM

	Cochrane paradigm	Theory of EBM
1. Target and mission	To fight against unscientific and uncertain information, and against unnecessary interventions	To make rational and effective decisions based on existing evidence, which may sometimes consist of uncertain or qualitative information.
2. Main problem in the search of evidence	There are too many studies and many of them are not reliable, therefore strict filtering is required.	Sometimes there are too many studies and you have to be very selective, but sometimes your problem is actually the lack of studies.
3. Main risk of a literature study	Subjectivity: The reviewer of literature continues the search until he finds literature that supports his original beliefs.	Dead end: Literature reviewer does not find enough evidence for making a decision, for example, a decision between "intervention" and "no intervention".
4. Who is a scientist?	Scientist is a person, who does not make decisions based on uncertain information.	Scientist is a person, who can make rational decisions based on existing empirical research (also based on small samples, qualitative data and mechanic plausibility).
5. Central subject position	Reviewer of literature	Medical decision maker (clinical practitioner or healthcare bureaucracy), Customer
6. Role of customers	Customer is a relatively insignificant or distant party, to which the reviewer of literature does not have direct contact.	Customers can participate to the formulation of research questions, and they should define the way in which the benefits and risks of the intervention should be weighted.
7. Who should participate in EBM	EBM is meant for clinical practitioners and healthcare bureaucracies, and not for nonprofessionals.	Medical decision maker and customer. In addition, practitioners of other sciences are welcome to medical decision-making (especially when mechanic, chemical or biological plausibility is evaluated) and to the continuous development of EBM.
8. If customer is included	Include customer at the very end of the process.	Engage the customer from the beginning of the decision-making process.
9. Proper way of doing a literature study	Delineate the literature study upfront to studies that meet certain strict criteria (e.g. to RTC studies only).	Do a pre-study to see, whether there are enough RCT studies, and if not, extend the literature search to observational studies and to the theories of mechanical, chemical and biological causality.
10. What is scientific evidence?	In practice, scientific evidence means RTC studies that have produced $P<0.01$ or $P<0.05$ at maximum.	Scientific evidence includes also studies with $P>0.05$, small samples, qualitative studies, and conclusions made based on mechanic, chemical and biological causality.

According to the theory of EBM, the *medical decision maker* should base its decision on the goals, preferences and constraints defined by the customer. In the case of clinical

decision making with one customer, the term customer may refer to the patient. However, when public health policy related decisions are made, the customer refers to the entire population of the country or municipality, or to the political representatives of this population (see Greenhalgh et al. 2014). The goals and preferences of the customer should be formulated into *measurable performance indicators* (see Akobeng 2005) that determine which option maximizes the benefit of the customer, without causing too high level of risks or side effects. Customer should be given the right to decide, how the different performance indicators are weighted against each other, for example, deciding how much weight should be put to economic costs or to the availability of resources, and how much weight should be put to the potential risks of the interventions. The task of the medical decision maker is to select, together with the customer, the option that maximizes the utility or benefit of the customer, under the constraints specified by the customer. The explicit interviewing of the customer to find the proper performance indicators and constraints is important, as otherwise the medical decision maker is likely to use its own professional values and traditional rules of thumb.

The options for the decision maker are usually "intervention" (e.g. use of a facemask) and "no intervention", although the set of alternative options may be larger due to the simultaneous existence of various alternative or complementing interventions. Figure 5 shows the proper decision-making process according to the theory of EBM:

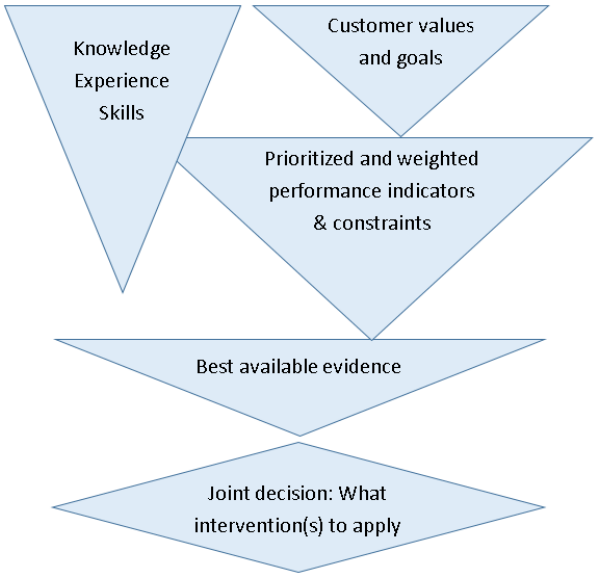

Figure 5: Decision-making process in the theory of EBM (adjusted from Akobeng 2005)

The decision-making process must produce a decision. The need for a clear decision is illustrated by the case of a physician, who is working in the emergency unit of a hospital. He or she must decide, how to treat the patient, and there is no real option for

waiting until scientists have executed more studies providing more complete and more convincing evidence (see Engerbretsen, Heggen, Wieringa and Greenhalgh 2016).

According to the theory of EBM, best available evidence must include also an understanding of the chemical, biological and physical mechanisms of an intervention, as this information might improve and enlighten the picture given by the RCT studies (Goodman and Gerson 2013; Lee et al. 2019; Chin-Yee 2014). For example, RCT studies still have not given hard, statistically significant evidence, that condoms would reduce the risk of pregnancy or that they would prevent the spreading of venereal diseases (Free et al 2009). Yet, we can conclude based on the models of mechanic causality that condoms are a useful intervention against unwanted pregnancies and venereal diseases. Another example are parachutes, which have not been proven in RCT studies to protect persons who need to jump from an airplane, because it would be unethical to arrange such an RCT study, in which the control group would be left without this protective equipment. Yet, we can conclude based on mechanical causality that it is better to jump from an airplane with a parachute than without a parachute.

Another problem of the Cochrane paradigm is its focus on those RCT studies that present $P<0.01$ values. This focus has no clear philosophical or scientific basis. We might as well decide, that $P<0.05$ would be sufficient. The newer editions of the Cochrane Reviewer's Handbook have tried to emphasize that also studies that have a $P>0.01$ should be given some value as evidence, for example concluding that they provide suggestive evidence (Cochrane Collaboration 2004, 144). Yet this rule of thumb of $P<0.01$ is so influential, that it has led to relatively wide usage of "P hacking" tricks for boosting the P values, or for representing the conclusions in a convincing but yet quasi-scientific manner (see the examples given in chapters 3.5 & 5.10 and in Rogers and Hutchison 2017).

The biggest problems of the Cochrane paradigm, compared to the theory of EBM, appear in a situation in which sufficient amounts of applicable RCT studies do not exist, or are still on a preprint level, waiting for a peer review. This situation will typically appear during the sudden global crisis such as a pandemic of a new disease. In such a situation the medical decision-maker, who applies the Cochrane paradigm, will be in a very challenging situation as the Cochrane paradigm instructs the decision maker to fight against uncertain information, not to utilize it. This dilemma will tend to lead to irrational solutions. One of these irrational alternatives is to *postpone decision-making*, which is not rational in a crisis when rapid decisions are needed (Simon 1957). Another irrational solution, which seems to be relatively common in Cochrane reviews and in healthcare bureaucracies, is to decide nothing and *push the responsibility of the decision to someone else*. A third alternative is to give an interview to the media, suggesting that the lack of evidence means that phenomenon X is not risky (as there are no evidence of risks) or that intervention Y is useless (as there is not enough hard evidence of its benefits). Although both of these conclusions are *arguments of ignorance* that should be avoided by all scientists, they are still relatively common (see chapter 5.10). All of these irrational and quasi-scientific applications of the Cochrane paradigm were used by tobacco companies in the court trials, in which they tried to postpone the conclusion

that smoking is harmful to the smoker. In general, we may create a simplified conclusion, stating that the Cochrane paradigm is a method for postponing decisions, while the theory of EBM is a method for making sure that decisions are made within the given time limit, in a situation of a urgency, crisis or emergency.

More empirical research would be needed for verifying, how much influence the Cochrane paradigm has actually had on the decisions of WHO, ECDC, CDC, STM and THL. Yet, there is evidence that at least some memes of the Cochrane paradigm are more popular in healthcare than what their counterparts in the theory of EBM are. For example, according to Sackett et al. (1996), "*If the study was not randomized we'd suggest that you stop reading it and go on to the next article in your search"*. The same rule of thumb has been repeated in various instruction and handbook texts. For example, Akobeng (2005) wishes to give practical advice to the practitioners of EBM, and suggests that it is enough if a physician learns two literature databases. After that, he focuses on explaining the benefits of the Cochrane database and especially its RCT register. This means the reduction of EBM into simple rules of thumb like "*go to the RCT register of the Cochrane database, if you need information*". Rules of thumb like this are examples of the "cookbook medicine" that has been criticized by Rogers and Hutchinson (2017, 12).

The STM (2020b) report gives a third example of applying the Cochrane paradigm on a rigid and exaggerated manner. The report was based on a strictly delineated literature review of existing RCT studies. Based on the absence of RCT level evidence, the report concluded that the benefits of facemasks are minor or non-existing (argument of ignorance). The report legitimized the decision of the Finnish government not to recommend facemasks to the public in spring 2020. A fourth example of the influence of the Cochrane paradigm is the reluctance of the health bureaucracies to increase their recommendations concerning the vitamin D intake, despite increasing evidence of the correlation of low vitamin D levels with high COVID-19 mortality (see chapter 5.7).

5.6. Discourses of bureaucracy, positivism and interventionism

Although evidence based medicine has taken steps away from the strict and exaggerated forms of the Cochrane paradigm, some memes of the Cochrane paradigm are still very persuasive, as they receive rhetoric support from the discourses of scientific revolution, enlightenment, positivism, bureaucracy, rational planning and welfare state. This rhetoric support emphasizes the need for the *rational authorities* use *fully reliable scientific information* to solve the real world problems that are caused by the *irresponsible and unpredictable* actors of the society. The construction of this rhetoric support is explained in the following chapters.

Scientific revolution led to the emergence of enlightenment, which was partially a campaign against superstitions and unscientific knowledge. This campaign and mission was supported by the emergence of positivism, which perceived science as a process that aims at producing empirically validated, certain and reliable knowledge. Although

positivism started to lose its popularity in social sciences already 1920[§§§], it remained highly influential within the natural sciences until roughly 1971, when one of its main proponents, Heisenberg, admitted that it is trivial to know something certain of unimportant topics, while remaining silent of the interesting and important topics, due to lack of empirical certainty (Heisenberg 1971, 213). Yet, on the same year 1971, Archie Cochrane laid the foundation for evidence-based medicine by criticizing the fact that as much as 10% of prescribed treatments to patients have been proven unnecessary in later investigations. Therefore, according to Cochrane, physicians should use only fully reliable information in their decision-making (Cochrane 1971, see chapter 5.5). The positivist fight against uncertain information appears in the Cochrane paradigm in the recommendation to beware, avoid or ignore information that has not been validated with RCT studies and $P<0.01$ values. The newer forms of evidence-based medicine no longer manifest this strong mission against uncertain knowledge, and instead, are able to value also observational and qualitative studies, and conclusions that are derived from models of mechanical, biological or chemical causality – at least, when better evidence is not available (chapter 5.5).

Discourses of bureaucracy are a genre of discourses, which include the *philosophy of the state* (e.g. Plato and Hegel), *early bureaucratic discourse*, characterized by Weber (1920–21), and the *later bureaucratic discourses* that appeared in the discourses of centralized planning, rational planning, interventionism, social democracy, and the welfare state ideology.

According to Plato and Hegel, the state is a superior or higher being, compared to the citizens that live in it. They also considered it possible to create enlightened and rational forms of government that would not be prone to despotism. (Harisalo & Miettinen 1995, 34–41). These ideas were then later on applied by nationalists, who wanted to create a national culture and a special nationalist spirit, which would then help in the defense of the state against external threats (e.g. Snellman 1842).

The focus on the importance of the state produced rhetoric support for the early bureaucratic discourse, according to which the *bureaucracy* is the ideal, rational and

[§§§] Scientific management, as described by Taylor (1910), started to lose its popularity 1920 due to the Hawthorne studies of Mayo and Roethlisberger (1920). In social sciences, Weber (1920-21) questioned positivism, see Scott 1998.

effective form of organizing government and public organizations. This discourse recommended that bureaucracies should be based on the following principles: [****]

1. Emphasis on laws, regulations, standards and other written instructions.
2. Nomination of public authorities to life-long positions to protect them from the despotism of the rulers and to let them make rational decision.
3. The organization of bureaucracies according to functions, so that each function of public administration can accumulate the expert knowledge on its own field.

According to this discourse, the application of these principles will create public organizations that are legitimate, rational, incorruptible and highly knowledgeable, due to the positive effects of the accumulation of expert knowledge to each sector of government, and to each function within each organization. The early bureaucratic discourse perceived the society and its organizations as a clockwork machine that just needs to be tuned up to be fully rational, fully informed and fully predictable. (Scott 1998.) This line of thinking led to the invention of *scientific management* (Taylor 1910), which intended to apply positivism also to the management of private and public organizations. Scientific management started losing its popularity in the 1920's due to the Hawthorne studies.[††††] This, however, only changed the discourse of bureaucracy and did not destroy it.

The later discourses of bureaucracy were constructed on the basis of Hegel's ideas of the superiority of the state. This idea, together with socialism, gave rhetoric support to *interventionism*, which meant the belief that the state should control and regulate the operation of people, enterprises, markets and the society in total. According to Hayek (1978) and Harisalo and Miettinen (1995, 34-41), the discourses of socialism, interventionism and welfare state all perceive public authorities as *rational and reliable problem solvers* while private enterprises are given the subject position of a *potential troublemaker*. In these discourses the citizens are perceived as *uneducated mass* that can be easily manipulated, programmed and controlled by the marketing of enterprises (for the bad of the people), or by a responsible government (for the good of the people). Another perception in these discourses is the conceptualization of the citizens as *irresponsible, unpredictable* and *mentally immature*. This suggests that that governmental bureaucracies should *patronize, guide, control, and tranquilize* the citizens (Hayek 1978, Harisalo & Miettinen 1995, 34–41). However, also some right-wing nationalists and elitists share this conclusion, based on ideas derived from Hegel, as they perceive it the responsibility of the church and the authorities, to civilize the uneducated and uncivilized masses of citizens.

From the point of view of political sciences, both the left and right wing discourses that emphasized the superiority of the state over its citizens can be seen as authoritarian, anti-liberal, or technocratic. This coalition of the left and wing discourses supported the

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[****] Weber 1920-21, see Scott 1998

[††††] Taylor (1910), see Scott 1998

construction of the bureaucracies and legal regulations of the welfare state in the western countries during the 20th century. In some cases the result was more authoritarian, and in some cases, more liberal (see chapter 6.3).

Figure 6, below, summarizes the connections between positivism, enlightenment, belief in the state, bureaucratic discourses and the Cochrane paradigm (at the bottom). Discourses are shown as blue circles, while the more detailed discursive elements and memes are shown with red color.

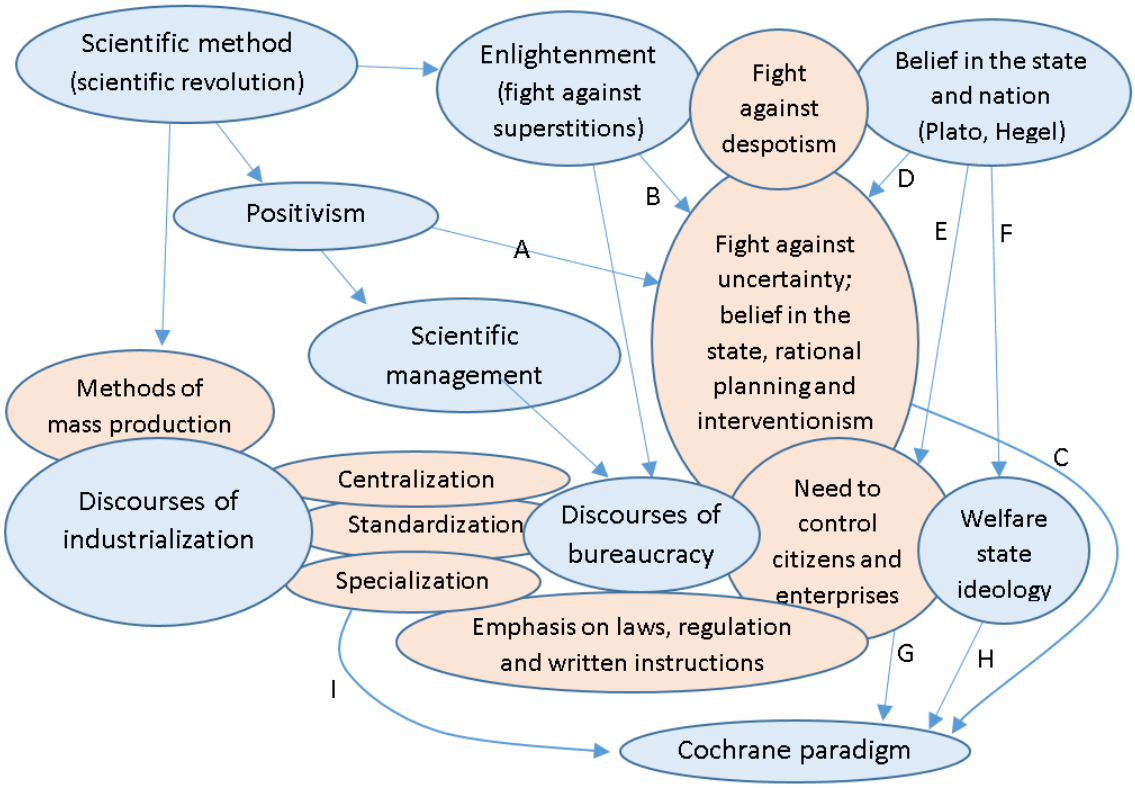

Figure 6: The connection of positivism, enlightenment, and bureaucracy to the Cochrane paradigm

Arrows A, B, and C show the rhetoric influence of *positivism, enlightenment* and *belief in the state and nation*, to the Cochrane paradigm, via the idea that it is *important to fight against uncertainty,* and via the *belief in rational planning and interventionism*. Both of these ideas resonate directly with the memes of the Cochrane paradigm, for example with the need for healthcare authorities to make decisions only based on information that has been validated in RCT studies (see 5.5).

Arrow E is the nationalist and elitist interpretation of Plato's and Hegel's ideas, leading to the conclusion that the (supposedly) rational and enlightened rulers of the state need to control and patronize the (supposedly) uneducated and unpredictable citizens, whose role is mainly to believe and obey the authorities. An example of this line of thinking is found in the report of the Finnish Police Committee (1968), which stated, "*It is the responsibility of citizens to trust police*".

Arrow F is the socialist interpretation of Hegel, which then later on led to the welfare state ideology via social democracy and via other moderate left-wing discourses. Examples of such moderate discourses are interventionism (e.g. Tocqueville 1969) and Keynesian economics (Harisalo & Miettinen 1995, 199). The coalition discourse of the nationalist, rational, and welfare discourses led to the construction of the national and international healthcare bureaucracies via arrow H.

Arrow G shows that the coalition of the more authoritarian left-wing and right-wing discourses led also to the conclusion that authorities should educate, control, patronize and tranquilize the *uneducated, irrational and unpredictable* citizens so that they would not cause harms to the society by spreading misinformation or by making uneducated decisions. This idea is still influential in the 21st century. The statement of U.S. Surgeon general (2020-03-13) is a good example, in the context of COVID-19:

> *"It is my belief as Surgeon General, that more people will die from misinformation, from panic, stigma, and discrimination than are going to die from the actual virus."*

This statement, which highlighted the irrational and panic-prone nature of people, was then promoted by social media activists (e.g. Bain 2020-03-13) and broadcasting companies (e.g. YLE 2020-05-09). It received rhetoric support even from some evolution psychologists who claimed that people tend to panic in crises, as panic is the *natural reaction* of humans to alarming information (e.g. Veissiere 2020).‡‡‡‡ This idea of "irrational and uneducated citizens" resonates with the Cochrane paradigm by suggesting that citizens should be kept out of medical decision-making, or that their engagement should be kept at minimum.

Arrow I shows, how the tendency of bureaucracies to employ highly *specialized experts,* led to the belief that *public authorities have the best possible knowledge.* This meme resonates with the Cochrane paradigm by suggesting that medical decision-making should be left to physicians and to the healthcare experts who work in public bureaucracies (see 5.5). This meme excludes the customers of healthcare, political decision makers and all scientists, who have not studied medicine.

The combined effect of arrows G and I is the idea that citizens should not interfere with the operation of public authorities by spreading their non-professional opinions in the media. During the beginning of the COVID-19 pandemic 2020, this meme was promoted by the spreading of a simplified interpretation of the theory of Dunning and Kruger (2009). According to the original theory, 1) people tend to overestimate their own knowledge on the fields at which they are not experts, 2) unless they have been given training in metacognitive skills (Dunning & Kruger 2009). The simplified version, however, ignores part 2 of the theory, and concludes that *all people* (including scientists)

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‡‡‡‡ The spreaders of these memes did not provide empirical evidence of the tendency of individuals, communities or societies to panic during situations of emergency and crisis. A brief look into scientific sources on the topic shows, that panic may be actually an exception and not the rule (e.g. Mawson 2005).

are so ignorant outside their own field of specialty that they should not even try to step out of their own field. This biased and simplified meme was spread, for example, by The Economic Times (2020-03-25), and by Weinman (2020-04-21). This simplified Dunning-Kruger meme resonates with the Cochrane paradigm, as it suggests that medical decision-making should be left to the healthcare professionals (see 5.5), excluding the customer and other non-professionals.

According to Toffler (1980), the values and principles of industrialization and bureaucracy were *second wave* ideologies and principles, which started to be over-thrown by the *third wave* on the second half of the 20th century. Table 8 summarizes the differences of the second wave and third wave ideologies in the context of public healthcare organizations. This table can be used for identifying additional connections between the Cochrane paradigm and the discourses of the second wave bureaucracies, and for analyzing the similarities between the theory of EBM (chapter 5.5) and the discourses of third wave public organizations.

Table 8: Comparison of 2nd wave health bureaucracies to the 3rd wave health organizations

	2nd wave health bureaucracies (and the Cochrane paradigm)	3rd wave health organizations (and the theory of EBM)
1. Who has the best knowledge?	Authorities of each highly specialized field of knowledge	Cross-functional and cross-scientific teams of experts
2. What is the best way to organize and manage?	Bureaucracy: Detailed laws and written rules are the foundation of everything, and all work in organizations should be based on highly specialized functions to accumulate knowledge within each function.	It depends: Bureaucracy may be suitable for highly stable environments, whereas unpredictable and changing environments tend to favor more flexible organization structures and regulations.
3. What does rationality mean?	Rationality means that all alternatives are compared based on reliable information and reliable prediction models.	Rationality means that a rationally justifiable decision is made based on available (imperfect) information and (imperfect) prediction methods within the given time constraints.
4. What is the role of citizens?	Citizens are the subjects of government and they should believe and obey the instructions of authorities. They should not try to interfere with the decision-making of public authorities.	The group of "citizens" consists of many important sub-groups (e.g. academics and journalists), and should therefore be permitted to criticize public authorities and to participate actively to the production of information and to the evaluation of proposed decisions.

5. Who is causing the biggest problems?	Irresponsible, unpredictable and uneducated citizens, and the enterprises that only seek to maximize their profits.	Rigid bureaucracies and regulations, that are incapable of adapting to the rapidly changing world, can be an equally big origin of problems as citizens and enterprises.
6. How should we reduce the problems?	The problems caused by citizens and enterprises can be most effectively solved by legal regulation and standardization.	The problems of rigid bureaucracies and regulations can be solved by defining different modes of action for the times of normality and crisis.
7. What is the role of scientific references?	Everybody knows that public authorities base their decisions on science, and therefore, scientific references need not be given to citizens.	Public authorities need to prove their expertise every time they make a statement or given an instruction. This can only be done by giving detailed scientific references that can be checked by journalists, academics and other citizens.
8. What is the role of Internet?	Internet is the source of unreliable information. People should be warned of the perils of Internet and social media.	Internet is the best source of information for scientists, authorities and citizens. Due to Internet, people can become prosumers of information.

Based on empirical findings within administrative sciences, the third wave memes on rows 1–3 and 6 are usually superior to the second wave memes, especially in complex or rapidly changing environments. §§§§ This means that second wave discourses,

§§§§ Project teams that combine specialists from various fields will have a wider perspective and set of knowledge than teams limited to one discipline. This will result in higher levels of innovation, especially if the team members identify themselves with the team, which (e.g. Van Der Vegt and Bunderson 2005). Rule based, highly specialized, functionally organized second wave bureaucracies tend to perform worse in rapidly changing environments than project organizations and other organic forms of organization. (Lawrence and Lorch 1967; Galbraith 1973; Scott 1998; Calabretta, Gemser and Wijnberg 2017; Abubakar et al. 2019). The intention of doing only rational decisions based on fully reliable information will tend to lead to decision paralysis, postponed decision-making, and bad results, when the available information is uncertain or partial (e.g. Simon 1951). Focus on increasing regulation, standardization, hierarchy and the exclusion of citizens or customers tends to make second wave societies rigid in such a manner that they have a "tunnel vision" and cannot react fast enough to rapid changes and crises. A solution to this problem, according to the third wave thinking, is to either loosen the rigidity of regulations permanently or by creating special "crisis modes" for the society, in order to speed up decision-making, engage the citizens, and to accept non-standard solutions under times of crisis. (Schraagen & ven de Ven 2008; Mendonca, Beroggi and Wallace 2001).

including the Cochrane paradigm, function best in a stable and predictable environment, while the third wave discourses, including the *theory of EBM*, function better when the environment is more unstable and unpredictable. In a situation of emergency – like the COVID-19 pandemic, the inferiority of the Cochrane paradigm compared to the *theory of EBM* is even clearer, according to the findings of administrative sciences and decision-making theory.

The memes on dimensions 4–5 are ideological, and have been already analyzed above in the context of interventionism and welfare state ideology. On row 7 the second wave meme "*authorities do not need to give scientific references to citizens"*, is based on the belief that citizens should believe and obey public authorities. Yet, it is a logical fallacy, which is generally called *argument from authority* by the philosophers of science (see chapter 5.10).

On row 8, the second wave meme is strongly against Internet, as Internet and social media are believed to confuse the roles of the producer and consumer of information in a harmful manner. The third wave meme, on the other hand, cherishes the fact that all the best information is currently available on the Internet and that it is accessible to all academics, authorities, journalists and citizens, who can act as *prosumers* (Toffler 1980) of information, not only consuming it but also improving its quality.

5.7. Discourses of health regulation

The discourses of *health regulation and safety* (abbreviated here as health regulation), contains the discourses *food and drug administration, occupational health*, and *product safety control.* All of these draw rhetoric support from the discourses of bureaucracy and are closely connected to the Cochrane paradigm. These discourses emphasize the risks caused by the enterprises and "quacksalvers" that wish to sell non-standardized and bad quality products or services to consumers, or who exploit their employees by not giving them sufficient protection against working environment related hazards. Due to this risk perception, they contain many references to standardized tests as a method for assuring the quality of the drugs, vitamins, protective equipment and other products that are produced by the enterprises.

If a product or production process is not standardized, then it is considered risky. For example, the FDA of United States reasoned that the facemask cleaning methods should remove viruses, be harmless to mask users, and not destroy the filtering ability or structure of the masks (Institute of Medicine 2006, 5). As no standardized cleaning method, that would have met these requirements, was available, the FDA recommended only the use of disposable masks. Based on this, a committee coordinated by the Institute of Medicine decided not to recommend cloth masks as personal protective equipment (Institute of Medicine 2006, 6).

The discursive origins of the health regulation discourses are summarized in Figure 7. The blue arrows have already been explained in chapter 5.6, whereas the red arrows are specific to the health regulation discourse. Arrow X indicates the strong connection of standardized products and methods with the health regulation discourse.

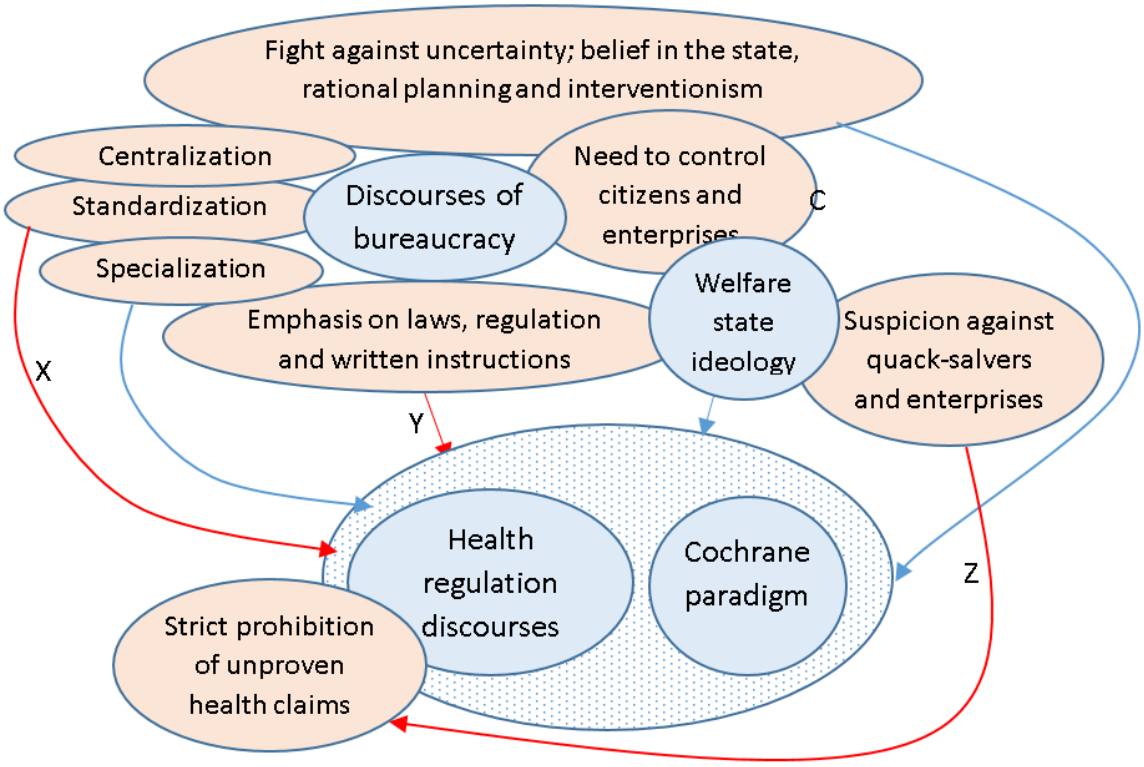

Figure 7: Discourses of health regulation in the sectors of food and drug administration, occupational health, and product safety

Arrow Y shows how the discourse of *bureaucracy* favors regulation, in general. The suspicion of the welfare state ideology against enterprises has promoted the development of legislation that protects consumers from the fallacious marketing messages of the enterprises (arrow Z). This is applicable especially to the marketing of drugs, foods, dietary supplements or personal protective equipment. For example, the FIOH stated in its information bulletin about facemasks, "*If a facemask does not comply to the EU regulations 2016/425 and the Finnish law about equipment for healthcare usage 2010/629, the facemask cannot be called a protective equipment*" (FIOH 2020b).

Due to the strong connection of health regulation discourse to law, the rules and concepts of this discourse tend to be dichotomous so that everything is either legal or not legal, and all products are either safe or they are not. For example, according to the health regulation discourse, a facemask either protects the employees enough (when it passes a certain standard test) or does not protect them enough (when such a test is not passed). Due to the memetic mutations that happen in communication networks, the word "enough" is often omitted, leading to a conclusion that a specific protective equipment either protects the employee (fully) or does not protect them (at all). This dichotomous perspective to "protection", together with some memetic mutations, seem to explain the conclusion of the press release of FIOH, according to which "*A self-made*

facemask will not protect its wearer" (FIOH 2020). This statement is logically fallacious, if we consider "protection" as something that is measured on an ordinal scale (less protection vs. more protection), and not as something purely dichotomous. Even if we were to define "protection" in a dichotomous manner, it is still misleading as cloth masks made by knowledgeable prosumers can actually provide very good protection for their wearer (e.g. Dato 2020 and Consumer Council of Hong Kong 2020).

Later on in December, the Finnish product safety authority Tukes (2020) applied this same black and white perception of protection, when they concluded, "*the results of the study show that community masks do not protect their wearer from the virus*". Tukes based its conclusion concerning community masks (i.e. cloth masks) on the following assumptions and logic:

1. Assumptions
    A. Coronaviruses are mainly spread by the droplets that are released when a person coughs or sneezes (based on quote from THL).
    B. The size of corona virus is only 0.05–0.2 micrometers.
2. Empirical results: Some cloth masks that were on the market, provided a filtering efficiency of 70% against particles of 3 microns, whereas the average filtering efficiency of the cloth masks was only 30% against particles of 0.2 microns.
3. Conclusion: Cloth masks do not protect their wearer against corona viruses, (as corona viruses are smaller than 0.2 microns.

Assumption A means that facemasks should mainly filter droplets (size range 10–100 microns), as they are supposed to be a more relevant route of contagion than air and aerosols. Assumption B is irrelevant, if assumption A is true.

This means that tests of filtering capacity should focus on the capacity of masks to filter particles of 10–100 microns, not particles of the size of virus (0.05–0.2 micron). According to the study of Tukes, over 50% of the examined masks had a filtering capacity over 70% against particles with the size of 3 microns. As the filtration capacity of cloths and masks generally improves when particle size is increased from 3 microns, we can conclude that over 50% of the tested masks would have had over 70% filtration capacity against virus droplets at the size range of 10–100 microns. Based on this, it would have been possible to conclude the study to the headline "*Half of the examined facemasks provided good protection against the virus*".

Even if we reject assumption A (that corona viruses spread mainly by bigger droplets), the conclusions of Tukes are highly misleading, as they are based on the biased perception that a personal protective equipment (PPE) either protects fully or does not protect at all. In this discourse, the PPE protects its wearer fully, if it meets the quality standards that relate to the PPE, otherwise it does not provide (sufficient) protection. In the discourses of health regulation, the word "sufficient" is frequently left out, making the conclusions genuinely dichotomous and exaggerated.

The fight against uncertain information, irresponsible enterprises, and "quack-salvers" is common also among the food and drug administration. In some cases, it even seems that the primary mission of the food and drug authorities is to fight against unreliable information, and against unnecessary products, treatments and diets. For example, the Finnish Food Authority (2020-03-31) published a strongly stated news bulletin, according to which

> *"There is no scientific evidence, that dietary supplements or specific foods could protect against corona virus or cure the COVID-19 disease. The marketing of foods and dietary supplements based on health claims is strictly forbidden and should be stopped immediately".*

Although the laws prohibit only *enterprises* from marketing their products with health claims, some authorities and journalists have started to believe that *nobody* should mention the potential health benefits of foods or dietary supplements. For example, the national Finnish broadcasting company YLE interviewed in March 2020 a Finnish doctor, Sari Arponen, who was treating COVID-19 patients in a Spanish hospital. In the interview, Arponen told that they treat patients with vitamins C and D, and with some rheumatoid arthritis medicines (Arponen 2020-03-24a). This same information about the benefits of vitamin C and D was also presented in her blog (Arponen 2020-03-24b). After one or two days, YLE removed vitamins C and D and rheumatoid arthritis treatments from the news article without putting a notice that the article had been edited (YLE 2020-03-26). At the same time, Sari Arponen also removed most of the material about the benefits of vitamin D from her blog. This episode indicates that the Finnish broadcasting company believes that nobody should publish claims of the health benefits of vitamins – not even journalists or doctors of medicine.

Another example of the fight against uncertain information, and against decisive changes to the status quo is the blog writing of THL (Virtanen and Tervahauta 2020). According to this blog, there is some evidence about the benefits of vitamin D in preventing the severe forms of COVID-19. However, a subtitle of the blog highlighted that "*there is not enough evidence of the benefits of vitamin D in the prevention or treatment of the corona disease*". The blog continued with the statement that Finns receive sufficiently vitamin D "*on average*". The conclusion of the blog was that "*there is no need to increase current vitamin D recommendations due to COVID-19*" (Virtanen and Tervahauta 2020). This line of reasoning resonates with the Cochrane paradigm, according to which healthcare bureaucracies should not make any decisions before fully convincing information and RCT evidence is available. It also resonates with the bureaucratic paradigm by trying to convince people that no special action is expected from them, at least not before they have first consulted a professional. This rhetoric is misleading, because 25% of the population suffers from the lack of vitamin D (Raulio et al. 2016) and 75% receive less vitamin D than what is recommended by some newer studies of 2020 (Kaufman et al. 2020, Merzon et al. 2020). If the Theory of EBM were to be followed, there would probably be enough evidence to give a recommendation for

Finns to consume vitamin D supplements during the COVID-19 pandemic, especially during the wintertime when D-vitamin is not produced in the skin due to sunlight. The potential harms and risks of vitamin D are small, as long as consumption of vitamin D remains below 100–125 micrograms per day and the concentration of D-vitamin in blood is lower than 100 nanomoles per liter (Paakkari 2020). According to the Theory of EBM, a rational decision about the intervention should be made by comparing the benefits to the risks. In this case, the benefits of vitamin D supplements seem probable and the risks seem unlikely, meaning that it would be rational to increase the recommendations concerning the vitamin D intake, especially during the wintertime. This is what some countries like USA, United Kingdom and Israel have already done.

5.8. Wish to imitate neighboring countries and the idea of herd immunity

The facemask report of STM (2020b) summarized the situation of most European countries concerning facemask recommendations. According to the report, none of the Nordic countries had recommended the use of facemasks to their citizens at the end of May 2020. The unified policies of the Nordic countries, which differed from the rest of the Europe, seem to be caused the tradition of *Nordic cooperation*, meaning the conscious attempt of the public authorities to align their policies, strategies and regulations with other Nordic countries. For example, the leading Finnish and Swedish authorities were engaged in frequent e-mail conversations, based on the e-mails published by the media (e.g. Iltalehti 2020). The following four memes seem to have been influential in the shaping of the COVID-19 policies and strategies of Sweden and Finland:

1. COVID-19 is an inevitable pandemic that will spread to all countries like influenza (Tegnell 2020a, Varhila 2020-03-16). It is not possible to suppress the epidemic, and all attempts to do so will only cause a more severe second wave.
2. The epidemic will not stop before herd immunity has been reached (Tegnell 2020b and Tegnell 2020c). Herd immunity refers to a situation in which about 40–70% of the population either have had the disease or have received vaccine.
3. Vaccination development normally takes several years. Therefore, the only way to create population-level resistance is to allow the disease to spread through the population.
4. In order to minimize lives lost due to COVID-19, the authorities should try to minimize the amount of senior citizens who are infected, while *maximizing* the amount of young people, who would get the virus – harmlessly and without risks (Tegnell 2020d, Järvinen 2020-04-23).
5. If school closures are minimized as much as possible, lives of senior citizens will be saved (Salminen 2020-03-15).

Meme 3 was an assumption that proved false, as the first large scale vaccinations started in less than one year of the beginning of the pandemic.

Memes 4 and 5 are based on the epidemiological models of THL that were never published or peer reviewed. Yet they seem to have been an important contributor to the decision of the Finnish government to reopen the schools in May 2020 just 2 weeks before the summer vacation period started. Although politicians did not repeat or quote this meme directly, they repeated the argument that COVID-19 is relatively harmless to children, and based on this estimate, considered the continuation of on-line school riskier for children than the re-opening of schools.

A bit less extreme postulation of the herd immunity discourse is the idea of flattening the curve just enough that capacity of ICU's would not be exceeded, but not suppressing the epidemic too much, as it was thought that suppressing the epidemic would cause a more severe second or third wave of the epidemic. The proponents of this argumentation line claimed that it is possible for skillful authorities to "move" some of the COVID-19 epidemic from late autumn 2020 to summer 2020, when the hospitals are normally less crowded than during the wintertime (THL 2020b and Järvinen 2020-04-23). This idea is a bit misaligned with meme 1, which emphasizes that the COVID-19 epidemic is very difficult to control. Yet, memes 4 and 5 assume that skillful authorities can effectively control the epidemic so that more children will get sick so that fewer senior citizens will die.

The memes of inevitable pandemic and the need for herd immunity have provided discursive support to the idea that too early interventions like a facemask recommendation, could disturb the natural spreading of the COVID-19 pandemic in summer 2020, and therefore cause a more severe second wave of the COVID-19 epidemic in the autumn 2020. Therefore, the herd immunity discourse gave indirect support to the decision of the Finnish government not to recommend facemasks in the summer of 2020.

5.9. Western self-understanding and xenophobic discourses

When cultural factors are merged to the decision-making concerning an intervention, it is also possible to use discourses as tools for building national self-understanding and national identity (see Alapuro 1995), and for distinguishing oneself from the alien and the other (Huntington 1996, pp. 29–72). For example, facemasks may be equated with burqas, niqabs, and shemaghs worn by the "strange" people of foreign cultures. This strange "other" can then be used as a means for strengthening national identity. Based on this, some forms of xenophobia may appear in any country.

Western self-understanding as an argument against masks

In Europe, *bad air* was considered the reason for diseases during the middle ages. During epidemics, people used facemasks with a curved "bird's beak" that had fragrant herbs and oils inside to neutralize the effects of bad air (Lynteris 2018). The scientific revolution, as well as the invention of bacteria, overturned the belief in bad air and made the facemasks downright ridiculous. In the beginning of the 20th century

scientists around the world believed that facemasks could not protect their wearer. This was based on the belief that diseases like plague are transmitted via bacteria, which are carried by flees and rats, or by the bodily fluids of infected people. Facemasks were perceived mainly as a means of protecting patients from the sputum of medical staff and from the bacteria transmitted through it (Spooner 1967).

During the lung plague of Manchuria, this paradigm changed. French physician Gérald Mesny wanted to prove that the plague is not transmitted through the air, and that facemasks are of no use (Lynteris 2018; Lei 2014, 26–27). He traveled to Manchuria and visited a plague hospital without a facemask, although his host, Doctor Wu recommended the use of a facemask. Mesny was infected with plague and died after a few days. This human experiment, despite its small sample, was so effective that scientists all over the world started to believe that diseases could actually be infected via air. This conclusion increased the interest towards facemasks dramatically all over the world. When the H1N1 epidemic, i.e. the Spanish flu, started 1918, almost all western and eastern countries promoted the wide usage of facemasks among the population. The western countries that were fighting in the World War I argued that facemasks were needed to keep soldiers healthy and to win the war. Therefore western countries promoted mask usage especially among soldiers (Kilbourne 2006).

After the war, western and eastern cultures started to differ in their attitude towards facemasks. In China, since the first appearance of medical facemasks 1910, the use of facemasks was considered a sign and symbol of *reason, science* and *political progress.* When doctor Wu developed a facemask made of cotton and gauze to protect healthcare professionals against pneumonia, the Chinese media and administration presented the masks as a visually impressive symbol of the progress, efficiency, and scientific nature of the Chinese administration (Lynteris 2018). This propaganda message was aimed to show the Manchurians, that separatism is not rational, since China is offering superior levels of reason, science and rationality. Thus, there was strong political support for facemask usage from the part of the Chinese government.

Throughout the 20th century, facemasks were a common intervention against epidemics in China. This was partly based on the Chinese culture, which emphasizes *obedience* and a sense of *community*, as opposed to the western cultures that emphasize individualism. Because of these Chinese cultural features, facemasks were commonly used during epidemics to protect the community from mask wearer viruses – not just to protect the mask wearer from other people's viruses. This cultural heritage is still influential in China during the COVID-19 crisis. For example, Cheng, Lam, and Leung justify the use of masks by altruism, solidarity, and the involvement of all members of the community in the fight against a global pandemic. *****

***** "Mass masking for source control is in our view a useful and low-cost adjunct to social distancing and hand hygiene during the COVID-19 pandemic. This measure shifts the focus from self-protection to altruism, actively involves every citizen, and is a symbol of social solidarity in the global response to the pandemic." (Cheng, Lam ja Leung 2020)

In Japan and elsewhere in the Far East, the rationale for using masks in the first half of the 20th century was the same as in China, i.e., it was based on a rational, scientific intention to protect the community against health threats (Burgess and Horii 2012). However, by the end of the century the use of masks had already been developed into a cultural ritual and practice without a clear link to the original scientific rationale. A new motive for the use of facemasks was e.g. the fact that they warm the face in winter, and in addition, they bring privacy and protection to the wearers from the eyes of other people in public places and means of transport (Burgess and Horii 2012).

In the western countries, the belief in the efficiency of facemasks to protect their wearer was greatly reduced after the World War I ended. A major reason for this was the report of Kellogg and MacMillan (1920), which questioned the benefits of widespread civilian use of cloth and gauge masks. The hypothesis was, that citizens would never learn to use them properly (see chapter 3.3). Based on the report, the Western medical community started to believe that only the healthcare professionals would be able to use masks properly. Surgical facemasks were perceived as a protective device to protect patients from the viruses and bacteria of the doctor, not to protect the healthcare workers against the viruses and bacteria carried by the patient (Spooner 1967).

By the 1970s, the world had been divided into two distinct cultures concerning facemasks, represented by the Western discourse that was skeptical about the efficiency of facemasks against viruses and bacteria, and the Asian discourse that emphasized the ability of the masks to protect the community.

The development of melt-blown technology and the development of fiber cloth surgical masks in the 1980s started to change the perception of western scientists concerning facemasks. The higher filtration efficiency of surgical fiber cloth masks meant that they could be possibly used to protect also their wearer, not only other people. Based on this, the Occupational Health discourse produced standards for securing the quality of surgical masks, as protective equipment for the healthcare professionals. This idea of the benefits of facemasks as protective equipment did not extend to the citizens outside healthcare professions.

By the year 2010, three alternative discourses concerning the usability of facemasks had emerged globally:

1. According to the Western discourse, the widespread use of facemasks among citizens was an expensive and culturally bizarre practice, the benefits of which were considered unknown or unproven (e.g. ECDC 2009, 3).
2. According to the Asian discourses, surgical masks and community masks, made of fiber cloth, were recommended to citizens during severe epidemics as protective devices, whereas washable cloth masks were perceived only as an emergency solution for the lack of fiber cloth masks (e.g. Consumer Councils of Hong Kong 2020). Masks were also recommended widely as a means of source control (see Jennings 2020).

3. According to the discourse of developing countries, disposable surgical masks were considered too expensive, and therefore, cloth masks were considered a realistic and pragmatic solution (see Kelkar 2013). This means that also healthcare professionals in hospitals frequently used cloth masks, at least until the end of the 21st century.

These three different facemask perceptions and discoursed created three different cultures for using facemasks. This distinction of sub-cultures is a typical reason for defining "the other" as something strongly opposite to "us". This may lead to cultural conservativism, meaning the slow adaptation of new and strange innovations like population wide facemask usage. In some cases, the cultural differences may emerge into slightly xenophobic paradigms that filter out information that would prove that the strange and new habits of different cultures would actually be rational, or even better than the local customs.

Although this xenophobic motive is hard to locate in western discourses, it is still possible to notice that for example the ECDC considered the benefits of handwashing against influenzas as "unknown, presumed" while the benefits of facemasks were only classified as "unknown" (ECDC 2009, 3). ECDC also published guidelines for member states, concluding that the benefits of masks are small, the disadvantages are likely, and the costs are huge (ECDC 2006, 19). These conclusions were made without a proper scientific analysis concerning the reasons that had led the Asian countries to use facemasks as a common intervention against virus epidemics. Lack of such analysis indicates that also other European countries wanted to perceive themselves as something European, and something very different from the Asian countries.

In the case of Finland, one may partially explain the disregard for facemasks in year 2020, by the long tradition of not recommending masks to citizens during influenza epidemics, not even 1918 when other Western countries gave this kind of a recommendation. Finland only recommended improved hand hygiene and coughing etiquette (Linnanmäki 2005). One reason for not recommending the masks may be the Finland did not need facemasks t*o win the First World War*, which was the argument many other European countries were using (Kilbourne 2006). Finland did not participate to World War I, and the civil war that Finland was fighting 1918 lasted only a few months. Another reason for Finland not recommending facemasks could be the wish to develop a national self-understanding, according to which Finland is different from others. According to Alapuro (1995), the construction of the Finnish self-understanding started already during the early years of the Finnish independence. According to Heiskanen (1983) and Alapuro (1995), the "*feeling of belonging*" is essential to national self-understanding. The authorities and politicians can artificially control national self-understanding through the media, especially if state has direct or indirect control over the media (Heiskanen 1983; Alapuro, 1995). National self-understanding works in the same way as the paradigms that guide thinking (Malmi 2009, 51–115). It rejects new, incoherent information that would be difficult to reconcile with previous views and beliefs.

The long-term work for the construction of national self-understanding seems to have created a situation in which the Finnish authorities actively ignored facemask positive and facemask neutral material that was presented in the western scientific sources, which were already quite sceptic towards the benefits of facemasks before year 2020. For example in year, 2009 STM published a national pandemic influenza preparedness plan, which did not mention the facemasks (STM 2012). When we take this facemask sceptic history of Finland into account, it is only logical that STM (2020b) concluded that the benefits of facemasks are "minor or non-existent".

One historical trait on the discourses concerning interventions against epidemics is the fact that all western countries emphasized the importance of the ventilation of interior spaces until 1960s, as a means of reducing epidemics. This belief was supported by the high frequency of tuberculosis even in the Western countries. In the STM plan against influenzas (2012), there was no longer any mention about the importance of ventilation. This seems to suggest that the belief in the contagion of epidemics via big droplets had replaced the earlier belief that tuberculosis (and other diseases) could spread via air. However, the Tuberculosis Association in Finland continues to emphasize the importance of ventilation for the protection of the family members of a sick patient (Tuberkuloosiliitto 2020).

5.10. Is fallacy the rule, and science an exception?

The following chapters combine the discourses of the second wave bureaucracies, occupational health, and food and drug administration to the memes of the Cochrane paradigm in a manner that produces fallacious conclusions, which are yet rhetorically supported, and enjoy some popularity, based on the examples given. The list of logical fallacies starts from the most influential one, the argument of ignorance, which is directly connected to the core memes of the Cochrane paradigm (see 5.5).

Argument of ignorance means the tendency of decision makers to conclude, "*We have not found enough scientific evidence for X, and therefore, X is not true."* Although this line of reasoning is popular and somewhat convincing, it is logically fallacious. For example, although the Spanish and Portuguese in the early middle ages did not yet have convincing evidence of the existence of the Americas, this lack of information did not prove that the Americas do not exist. The argument of ignorance gains discursive support from the bureaucratic discourses of the 2nd wave, according to which citizens are *prone to panic*, and that therefore, authorities should avoid giving any alarming or worrying information or conclusions to citizens (see chapter 5.6).

Healthcare authorities frequently used arguments of ignorance during 2020 in order to belittle risks, using the following structure: "*Due to lack of evidence of risk R, there is no need to worry about risk R".* For example, in the beginning of 2020, scientists were not sure whether the virus spreads mainly from animal to human or from human to human. Based on this lack of information THL, WHO, and the state epidemiologists of Sweden, Anders Tegnell, gave the following statements:

- "*An animal source seems the most likely primary source of this novel #coronavirus (2019-nCoV) outbreak, with some limited human-to-human transmission occurring between close contacts.*" (WHO 2020-01-20).
- "*The risk of a global pandemic is low"* (THL 2020-01-16)
- "*It is improbable that the virus would spread to Sweden in any significant manner*" (Tegnell 2020-01-20).
- "*Travelling in China does not induce a notable risk*" (THL 2020-01-23).
- "*The epidemic does not threaten popular winter vacation destinations like Thailand, according to current knowledge*" (THL 4.2.2020).

The statements given in the examples below were given without scientific reference and based on very limited scientific knowledge of the mechanisms of infection. While the WHO did not make exaggerated conclusions based on the lack of information, THL and Tegnell used the lack of information as an argument for concluding that risks are small. One motive for doing so may have been the idea that global fear and panic are more dangerous than the actual COVID-19 pandemic.

Another example of the belittling of risks is the way in which the press release of the Institut Pasteur (2020-06-22) was interpreted. According to this press release, researchers have found "*No significant transmission among children or from students to teachers*". Based on such lacking evidence of transmission from children to adults, the American Academy of Pediatrics urged schools in August 2020 to open for in-person learning, stating "*Although many questions remain, the preponderance of evidence indicates that … children may be less likely to become infected and to spread infection.*" (Haffajee 2020). In other words, lack of evidence of children's capacity to spread the virus was used as an argument to conclude that schools should be opened.

Based on the internationally popular belief that children might not spread the virus to adults, also Finland decided to re-open the schools in mid May 2020, two weeks before the summer vacation started. This decision received support also from the herd immunity discourse, according to which it is important to maximize the "harmless" COVID-19 infections of children in order to build herd immunity against the disease (see 5.8)

Another application of the argument of ignorance takes the form of belittling the benefits of some intervention, based on not being able to find evidence of the benefits. For example, STM (2020b) applied this reasoning to conclude that the benefits of facemasks are "*minor on non-existent*", based on the fact that the consultant company that was doing the literature search had not found enough RCT level evidence of the benefits of facemasks.[†††††] Even if the public authority may have given the original

[†††††] Actually, the consulting company found a meta-study (Barasheed 2016), which showed that according to RCT studies facemasks give notable benefits by protecting their wearers against contagion of respiratory diseases, although the results were not statistically significant against any specific disease. STM ignored this meta-study when the abstract of the study was

version of argument of ignorance in a somewhat cautious form with some disclaimers, the media is likely to take away the disclaimers, and exaggerate the message to full-blown arguments of ignorance. For example, the original message "*We have no evidence of the benefits of facemasks and therefore we do not recommend them*" will tend to mutate to the message "*authorities do not recommend facemasks*" or even to the clearly fallacious message, "*facemasks do not protect their wearer*". Such a mutation happened, for example, after the first press release of FIOH, in one local newspaper (Kaleva 18.4.2020).

Decision paralysis means the tendency of decision makers to postpone decisions, when they feel that they have not enough information to make a decision. The risk of decision-making paralysis is augmented by the ideas of Cochrane paradigm, which emphasize, that bad quality information should not be used as a basis of decision-making. This conclusion is against the principles of the theory of EBM (chapter 5.5) and against modern theories of administrative decision-making (e.g. Simon 1951, see Kheirandish & Mousavi 2018). A good example of decision paralysis is the blog of THL (Virtanen and Tervahauta 2020). According to the blog, there is not enough evidence to recommend vitamin D for citizens, to reduce the risk of serious forms of COVID-19. In this case, THL presented quite a bit of evidence of the lack of vitamin D being a risk factor for serious forms of COVID-19. They also gave a reference to a study, which showed that about 50% of the Finns receive less vitamin D than the recommended amount. Based on this amount of evidence, the decision paralysis still led to the conclusion "*there is not enough information to make a decision*" (see chapter 5.7).

Argument of popularity means argumentation, which assumes that popular and widely spread arguments are true. For example, in Finland there is a consensus that people should get enough vitamins from the normal food they consume, without using vitamins as a dietary supplement. This idea, which has been persistently repeated by the Food Administration Authority, is connected to the bureaucratic belief that enterprises, on the sector of health, are constantly trying to sell unnecessary dietary supplements. Therefore, the emerged *self-understanding* in Finland (see 5.9) is that Finns should not waste their money on vitamins as dietary supplements. This has led to a situation, in which leading authorities on the healthcare sector (e.g. Virtanen and Tervahauta 2020) prefer to remain aligned with popular opinions and paradigms, even if that requires the ignoring of empirical evidence about the need for Finns to consume more vitamin D.

Argument from bureaucracy is a sub-category of the argument of authority. We could call it as "*argument from de jure authority*" (Woods & Walton 1974, 146), but argument from bureaucracy is a shorter and more specific concept in the context of public bureaucracies. When public bureaucracies use this fallacy, they expect the audience to believe their predictions, estimates, recommendations and decisions without giving proper scientific references. The clearest examples of argument from

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written. This indicates that the conclusions of the study had been decided already before the literature study was completed.

bureaucracy tend to appear in the interviews, press releases, and strategy papers of healthcare authorities, which often contain no scientific references at all (e.g. FIOH 2020 and HSC 2005). However, even the more scientific texts like technical reports and influenza preparation plans tend to manifest the argument from bureaucracy either by quoting only other bureaucracies, or by putting the scientific references to the end of the text without connection to the main arguments of the text (e.g. STM 2012). Sometimes the minority of the references mentioned at the list of references have been clearly referred to in the text, while the majority exist only to give extended credibility, and to give the impression that the experts of the bureaucracy have read a lot – and therefore, are experts (e.g. ECDC 2009).

Argument from bureaucracy gains rhetoric support from the discourses of bureaucracy, which perceive citizens as *subjects of government*, who have the *responsibility* to believe in authorities (see chapter 5.6). Based on this discourse, only public authorities possess, manage and distribute proper knowledge. The tendency of authorities to argument from a position of authority has been criticized, for example, by Patomäki (2020) and Sivonen (2020).

Fallacy of esoteric knowledge means the tendency of specialists in some field to consider themselves immensely more knowledgeable in their field of expertise than the "non-professionals" or "laymen". It is typical that these specialists distance themselves from the wider audience by using an incomprehensible language, complicated and fuzzy concepts, or highly advanced mathematical equations. These can all be seen as methods for trying to raise above all criticism, to the position of the wise, holy and the knowledgeable.‡‡‡‡‡ An example of such a fallacy can be identified in the reluctance of THL to open up its epidemiological models, equations, parameters and assumptions to the public and to the scientific community (Uusi Suomi 2020-06-30). Such lack of transparency is dangerous; especially if these models are used for highly controversial and influential conclusions like the idea that *keeping the schools open as much as possible during the COVID-19 pandemic will reduce the deaths of the elderly people* (see chapter 5.8).

During the beginning of the COVID-19 pandemic 202, the fallacy of esoteric knowledge was frequently promoted by the use of a biased and simplified interpretation of the *Dunning-Kruger effect* (see chapter 5.6).

Argumentum ad nauseam is based on the belief that the frequent repetition of an argument will gradually make the argument true. THL promoted this approach in their strategy paper, published by ECDC (Lohiniva et al 2020), which offered to citizens the subject positions of *troublemaker* and *irrational and uneducated laymen*. The report belittled the risk perceptions of citizens in a manner, which seemed to lead to the conclusion that the real problem is not COVID-19, but it is the fears of people. The recommended mitigation to solve this problem was the repetition of "reliable information" to the citizens, ad nauseam, and without scientific evidence, using

‡‡‡‡‡ see Mäki (2002)2002) and McWilliams (see Campbell-Verduyn 2017)

argument from bureaucracy as principal method (Lohiniva et al 2020, 2). The same idea of the importance of repeating the same message is found in the materials of CDC, which emphasize that it is important to give "*accurate, timely, consistent, and credible*" information to citizens (2006, 1). The requirement for a consistent message ignores the fact that during a crisis, the "true perception" of the problems and solutions may change at a very rapid pace. If consistent information is required, authorities will have a low incentive to admit their errors or to stop spreading the fallacious conclusions they had made earlier. This is likely to repetition of the same fallacious message to citizens, ad nauseam. This fallacy may be promoted by the bureaucratic discourses, which perceive people as prone to panicking, unless authorities are able to tranquilize them (see 5.6).

Ad-hoc alterations of the paradigm mean a situation, in which the proponents of a paradigm make minor ad-hoc adjustments to the peripheral memes of their paradigm, while keeping the core idea of the paradigm intact. A good example of this is the way in which AAP reacted to the new evidence that emphasized the significant role of children as spreaders of COVID-19. Based on this new evidence, AAP changed made minor changes to its web pages later in autumn 2020, but kept the core meme of its paradigm unchanged. According this core meme "*APP continues to strongly advocate that all policy considerations for school COVID-19 plans should start with a goal of having students physically present in school.*" (AAP 7.1.2021).

When authorities finally notice that their paradigm is completely conflicting to the newer empirical evidence, they are tempted to hide the evidence that would prove they were wrong, and that their paradigm was fallacious. This means that authorities sometimes re-edit or remove old press releases, without giving an audit trail to show the changes. An example of such a re-edition of an old press release is found on the 7.1.2021 version of the press release that FIOH published in April 2020 (TTL 2020). The older press release stated clearly that self-made masks do not protect their wearer. In the newer edition, the expression "*do not sufficiently protect*" has been added to text, softening the original and clearly fallacious statement. Yet, the main headline still stayed in the original format that suggested that cloth masks do not offer any protection at all.

Conservative fallacy means the tendency of the decision maker to conclude that current beliefs and practices are ideal (without any extra evidence) while vast amounts of hard evidence are required before new knowledge, custom or intervention can be adopted. The cautiousness against new ideas and interventions could be interpreted as rational cautiousness. However, when this extreme cautiousness is combined with the uncritical acceptance of the status quo, it becomes a logical fallacy. This conservative fallacy is also against the principles of EBM. According to EBM, decision makers should compare the alternatives "*intervention*" and "*no intervention*" from an unbiased point of view, requiring equally strong evidence for both alternatives. An example of conservative fallacy is found in the ECDC report (2009), according to which the benefits of improved hand-hygiene are "*unknown but presumed*" while the benefits of facemasks are just "*unknown*". In other words, ECDC believed that traditional customs are good and beneficial, while new customs should not be used, before large amounts of evidence

are provided. Another example of the conservative fallacy is the statement of FIOH (2020), according to which "*The best ways to protect oneself against the coronavirus is to stay home, keep a safety distance of 1–2 meters and to wash hands frequently*" (FIOH 2020). This statement describes the traditionally accepted "status quo" interventions against virus infections and recommends them without any scientific evidence, while the new, potentially beneficial intervention of facemask usage is completely left out of the list.

The appearance of conservative fallacy is connected to the Cochrane paradigm, which has a clear mission for fighting against such new drugs, food supplements, treatments and protective equipment, which have not yet been found beneficial based on RCT studies and $P<0.01$ values. In this discourse, one rarely uses equally much energy for finding evidence to support the traditional beliefs of the medical community – even in those situations, in which the traditional belief was based on weak empirical evidence or fallacious conclusions. For example, the medical community of the western countries has believed relatively consistently during the last 100 years that viruses spread mainly via big droplets and via contaminated hands, not via aerosols. This has led to the conservative fallacy, according to which contagion via couch droplets and contaminated hands is a "proven" truth (without hard evidence) whereas contagion via aerosols is a new and strange idea, which requires enormous amounts of evidence for its support.

Mixing science with politics means a situation, in which scientific arguments are mixed with political argument without transparency. This makes it difficult to see, which part of argumentation is scientific and which is political. A good example of this kind of argumentation was presented by U.S. Surgeon General, when he claimed on a political basis that facemasks should be reserved to healthcare workers and then tried to argue on a (quasi) scientific basis that facemasks will not protect other people than healthcare workers (chapter 5.4). When science and politics are mixed, the quality of argumentation suffers. Scientists will wish to avoid participation to such topics, as they do not wish to be too much engaged in political argumentation. Members of the parliament and government, on the other hand, feel uncomfortable participating to scientific argumentation. In such a situation, rhetoric power may cumulate to the few persons, who claim to hold both the political and the scientific authority. In Finland, such a person is the permanent manager of STM, Kirsi Varhila, who had the power to act as a liaison between the upper government and the THL. The power of the liaison position between government and a national expert organization is based on the ability of the liaison to give to politicians the impression that she holds superior expert knowledge, and on her ability to give the expert organization the impression that she holds superior political knowledge.

If someone takes simultaneously the authority to conclude political decisions and scientific knowledge, there is a risk that neither scientists nor politicians have the courage to question these statements: Scientists do not wish to engage in political debates, and politicians do not wish to give statements of scientific topics. Evidence-based medicine supports the decision-making process by clarifying that customers (e.g.

citizens or politicians) should specify the values, goals and constraints of the intervention while healthcare specialists should make an educated decision between "intervention" and "no intervention" based on the available scientific information and customer values, without letting politicians to pressure them to any specific direction.

Unethical science: According to positivism in general, and the Cochrane paradigm in specific, scientist can find the truth by rigorous studies that reveal statistically significant evidence. In practice, this is evidence, in the field of medicine, is usually interpreted as RCT studies that produce P<0.01 values. The ability of a scientist to produce P<0.01 results in a study is used as a measure of his scientific skills. These conclusions create pressure for scientists to present RCT studies that show P<0.01. On the other hand, the reviewers of scientific reports may only focus on spotting the abbreviation RCT, and on glancing through the P values to see that they are smaller than 0.01. This routine of quickly glancing the study for P values may have been the cause for ECDC to conclude, based on the report of MacIntyre et al. (2015), that that cloth masks are not a solution to the lack of surgical masks (ECDC 2020b). A closer look to the study would have revealed several methodological and ethical problems, which are described in chapter 3.5.

5.11. Summary of the facemask sceptic discourses and memes

The argumentation against facemasks appears in scientific, quasi-scientific, political, administrative and popular discourses, which are all connected to the culture and history of each country. Discourses influence each other by emitting, receiving and sharing *memes*, i.e. *discursive elements*. Discourses are normally constructed around some core memes that remain unchanged over longer periods, but they also contain peripheral memes that have a weaker logical connection to the core or appear less frequently. Due to the emergence of peripheral memes, scientific discourses tend to be converted to bureaucratic and popularized discourses and practices, which also contain unscientific and logically fallacious memes. Memetic discourse analysis is a method for analyzing, how scientific memes convert to fallacious and highly misleading memes in a complicated network of scientists, public authorities, journalists and social influencers, and to what extent the processes of science are able to correct the misinformation that is spread around.

The results of the study are summarized to Figure 9 below. It shows with blue color those discourses that have produced argumentation against facemask usage. The red ellipses show those arguments, beliefs and other discursive elements (memes) that provided discursive and rhetoric support for the conclusion that facemasks should not be recommended to asymptomatic persons during the COVID-19 pandemic.

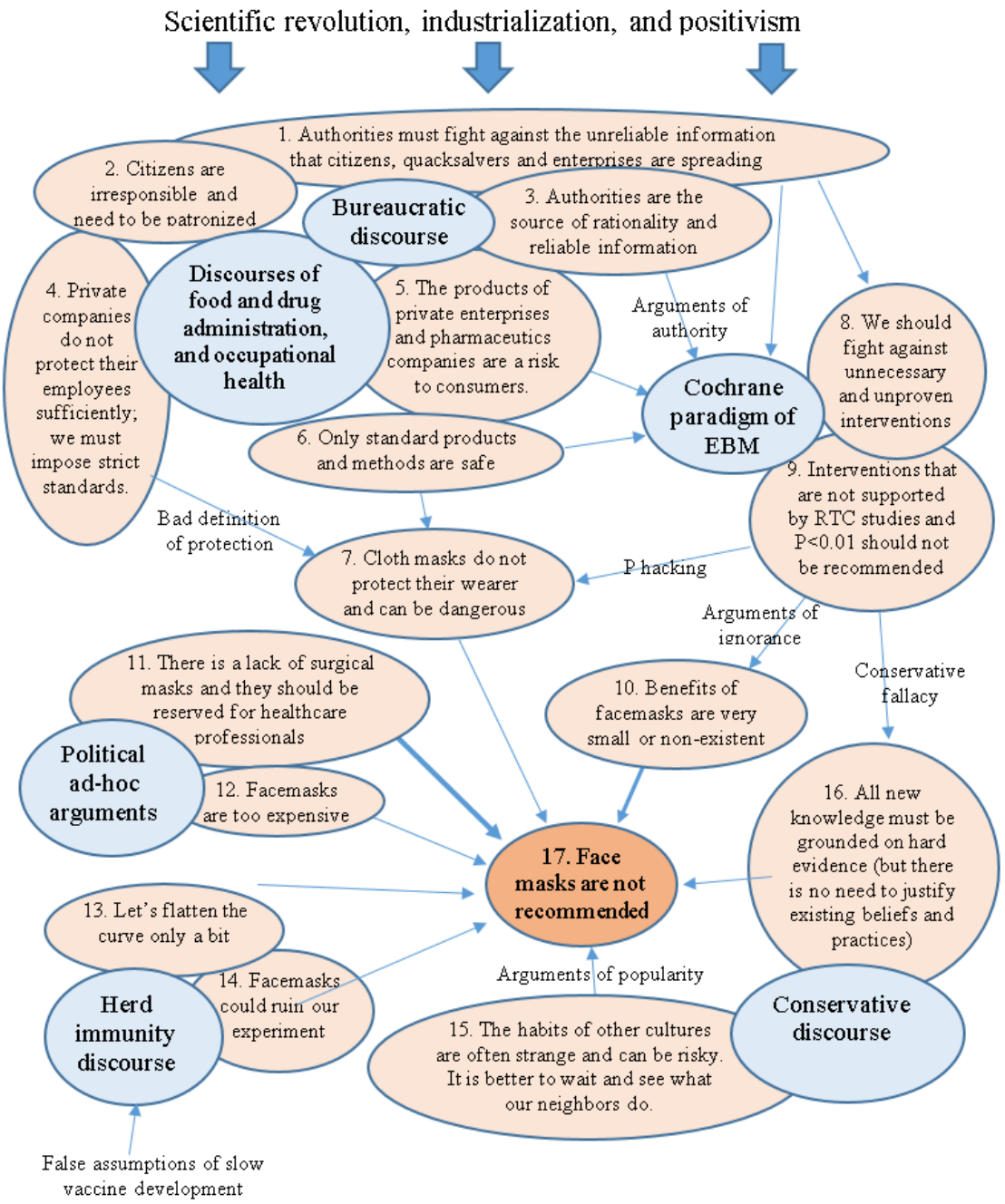

Figure 11: The discourses and memes against facemasks

Meme 19 in the center, "*facemasks are not recommended*" is the combined output of all these discourses. This meme, however, appears in different versions. The most severe version was the misinterpretation, according to which "*authorities recommend that people should not use facemasks*", while the most moderate interpretation was that "*authorities do not yet have enough information to recommend facemasks*". The popularity and influence of the misinterpreted version of meme 19 is shown by the fact that some Finnish schools prohibited facemasks usage in spring 2020, and still in the early August 2020, a big Finnish grocery store chain forbid facemask usage from their

employees (chapter 5.3). The historical background of the mask-negative argumentation relies on scientific revolution, industrialization, and positivism, which together created an optimistic feeling that rational public authorities can solve all the problems of society, based on scientifically validated information (chapter 5.6). This led to the belief that only industrially produced standard products, which have been tested in standardized quality tests, can be good for people (chapter 5.7). Another common conclusion was, that knowledge that is not proven in RCT studies with small enough P values, is unscientific and relatively worthless. These conclusions fueled the work of Archie Cochrane (1971), and the fight against medical treatments that have not been proven effective in RCT studies. It also fueled the idea that rational authorities are the source of reliable scientific information, whereas citizens and enterprises were given the subject position of potential troublemakers. The idea that "*authorities are reliable*" seems to have led to the reluctance of healthcare authorities to make decisions or to give recommendations based on impartial or uncertain information (see 5.5). This, however, tends to lead to media interviews in which authorities first tell that they do not have enough information to conclude anything – and then they conclude that risks of disease X are small or that the benefits of intervention Y are very minor, without giving other justification for the conclusions than their position of authority (chapter 5.3).

Evidence-based medicine (EBM) evolved rapidly to produce a well-functioning process model for making decisions and recommendations also based on uncertain information. Yet, the *Cochrane paradigm* of EBM remained focused on systematic literature reviews, with very little contact to the customers of the interventions. Cochrane paradigm also focused more on its mission against inferior and uncertain information, which in practice, meant everything that is not an RCT study with $P<0.01$. The tendency of the bureaucratic discourse to promote *arguments of authority* was also inherited to the Cochrane paradigm in the form of reluctance to accept anybody else than university trained physicians to medical decision-making. This exclusion of "non-professionals" also left the wider scientific community out, and greatly reduced the ability and motivation of the promoters of the extended Cochrane paradigm to use scientists of other fields as producers of relevant information. This also meant that the promoters of the extended Cochrane paradigm tended to ignore the analysis of mechanic plausibility (e.g. the filtration capacities of facemasks) in their decision-making (chapter 5.5).

The exaggerated focus at RCT studies seems to have been a cause for the relatively common "*argument of ignorance*" fallacy, meaning the tendency of authorities to conclude that intervention X is useless, if the literature reviewers were unable to find evidence of its benefits. This conclusion appeared in in the facemask report of STM, which concluded, due to the lack of sufficient RCT studies, that the benefits of facemasks are "*minor or non-existent*" (STM 2020).

The most widely used argumentation line against facemasks seems to have been the combination of political meme 11 (lack of surgical masks) with the unscientific meme

10 (benefits of masks are minor or non-existent). This combination leads to the illogical conclusion, according to which

"There is no proof of the benefits of facemasks for common people, but for healthcare workers the facemasks offer so much protection that all facemasks should be reserved for them."

The influence and popularity of this meme is indicated by U.S. Surgeon general's Twitter message (2020), in which the logic of argumentation is the same, and only the wording is different. This meme appeared to some extent also in the texts of WHO and ECDC (chapter 6.2), spiced up with the idea that it would be extremely difficult for people to learn the proper use of facemasks (meme 2).

An alternative way for handling the lack of surgical masks would have been the recommendation of cloth masks to people. This was the approach chosen by CDC, after it had first followed the mask-sceptic argumentation line promoted by WHO and U.S. Surgeon General (chapter 6.2). The promotion of cloth masks, however, was problematic to ECDC due to their exaggerated conclusion that *cloth masks can be dangerous,* which was based on one questionable study (chapter 3.5). Acceptance of cloth masks was also difficult for the ECDC due to the discourses of health regulation, which considered all protective equipment either *fully protective* and useful, or completely *unsafe and useless* (chapter 5.7). This created a curious situation, in which CDC recommended cloth masks, whereas in Finland, cloth masks were considered dangerous, and some schools and one major grocery store prohibited the use of all kinds of facemasks from their employees (chapters 5.3 and 6.2).

The tendency of the Cochrane paradigm to lead to *conservative fallacy* (chapter 5.10) was amplified by the general conservative discourses of the Western societies, which considered facemasks as something *strange and potentially risky* (meme 17). The conservative discourses are rhetorically connected with *arguments of popularity*, meaning the idea that if other countries close-by believe in some intervention, we should use it, otherwise not.

The discourses of bureaucracy and regulation created discursive support, especially in Finland, for *rational interventionism*, meaning the belief that government and health authorities can control skillfully and effectively the society in general and COVID-19 epidemic in specific. This ideological background gave support to the idea that authorities should maximize the infections of young people (to gain herd immunity without risks) while protecting the old, and that some infections should be "moved" from autumn 2020 to summer 2020 (memes 14 and 15). This contributed to the decision of the Finnish government not to recommend facemasks in late spring 2020 and instead to postpone the recommendations to August 2020 (see chapter 5.8).

Another political argument that was used against facemasks, ad-hoc, was the idea that facemasks are too expensive for poor people, and therefore it would be unfair to recommend them unless the government would pay the masks. Some memes of the diagram remain hypothetical without empirical evidence that would prove their relevance. This is, for example, the case of meme 13 (see chapter 5.8 for details).

6. The change of mask recommendations in Europe, USA and WHO

The previous chapter presented a review of the scientific, bureaucratic, cultural, historical, political discourses and memes that worked against facemask recommendations. The following chapters analyze, how these discourses have shaped the attitudes and recommendations of WHO, CDC (USA) and ECDC (Europe) concerning facemasks before COVID-19, and during the COVID-19 pandemic.

6.1. CDC, ECDC and WHO before COVID-19

In Europe 2009, the ECDC published its instructions for its member states concerning the proper way for preparing for influenza pandemics (ECDC 2009). This report concluded in its page 3 that

- The benefits of facemasks are unknown, costs would massive, and the practical difficulties in training people to proper mask usage etc. would be massive
- The benefits of hand-hygiene are unknown but probable, and the practical challenges relating to hand-hygiene are only moderate.
- The benefits of cough and sneezing etiquette are unknown but presumed, and the practical problems relating to this theme are small.

Social distancing and safety distances were not mentioned in the report. This summary seems to fall to the conservative fallacy, according to which traditionally trusted interventions are presumed beneficial (without evidence) whereas new and "strange" interventions are not recommended unless hard evidence of benefits, and of the lack of practical problems, is presented. The influence of the conservative fallacy is underlined by the fact that facemasks were actively used in Asia to fight against the SARS outbreak 2002–2004, and against the swine flu pandemic 2009, during the last 9 months before the publication of the ECDC report. The ECDC report (2009) also resonates with the bureaucratic discourse (see chapter 5.3), according to which the citizens are uneducated, irresponsible, and difficult to train to proper manners – and therefore, massive problems would occur if facemasks were to be introduced to the European people.

In the USA, the Homeland Security Council published a National Strategy for Pandemic Influenza (HSC 2005) and National Strategy Implementation Plan (HSC 2006). Neither of these documents mentioned facemasks as a potential non-pharmaceutical intervention to protect the public. The ignoring of facemasks continued in the CDC instructions for households 2017, which recommended only the following personal protective measures:

> *"…staying home when you are sick, covering your coughs and sneezes with a tissue, and washing your hands often with soap and water" (CDC 2017, 4).*

The ignoring of facemasks seems to indicate lack of scientific vigilance from the part of CDC, as first extensive meta-studies of facemasks had already published several years before (Jefferson 2011), and as facemasks had already been systematically used against SARS (Asia 2002–2004) and MERS (e.g. South Korea 2015).

The WHO differs from CDC and ECDC, as it is global organization, meaning that it has to find a balance between the points of view of Western, Asian and developing countries. This principle applies also to the need for synthesizing the following three high-level facemask discourses that had emerged by the start of the 21st century:

1. The Western mask-sceptic discourse (CDC & ECDC)
2. The Asian discourses that promoted the use of fiber cloth masks also among asymptomatic people (see Burgess and Horii 2012 and Jennings 2020)
3. The discourse of the developing countries, which perceived cloth masks as a practical and realistic alternative for the expensive fiber cloth masks.

In 2009, the WHO recommended use of masks only for symptomatic individuals during influenza pandemics (WHO 2009, 43). However, in October 2019 WHO extended the mask usage recommendation also to asymptomatic persons, at least during highly severe pandemics (see table below):

Table 9: WHO recommendations concerning non-pharmacological interventions (WHO 2019, 3)

Table 1. Recommendations on the use of NPIs by severity level

SEVERITY	PANDEMIC[a]	EPIDEMIC
Any	Hand hygiene Respiratory etiquette Face masks for symptomatic individuals Surface and object cleaning Increased ventilation Isolation of sick individuals Travel advice	Hand hygiene Respiratory etiquette Face masks for symptomatic individuals Surface and object cleaning Increased ventilation Isolation of sick individuals Travel advice
Moderate	*As above, plus* Avoiding crowding	*As above, plus* Avoiding crowding
High	*As above, plus* Face masks for public School measures and closures	*As above, plus* Face masks for public School measures and closures
Extraordinary	*As above, plus* Workplace measures and closures Internal travel restrictions	*As above, plus* Workplace measures and closures

The recommendations were based on the WHO's overall assessment of the benefits and harms of different non-pharmacological interventions to control an influenza pandemic

(WHO 2019, 20–26). Table 10 summarizes the results, giving references to page numbers of the WHO report in parentheses:

Table 10: Benefits of facemasks, coughing and sneezing etiquette, hand hygiene and avoiding crowding

	Facemasks	Coughing and sneezing etiquette	Hand hygiene	Avoiding crowding
Scientific studies	N=10 (10 RCT-studies)	N=80 (0 RCT-studies)	N=12 (11 RCT-studies)	N=3 (0 RCT-studies)
Statistical findings	Facemask usage, combined with hand hygiene reduced contagion risk by 22% according to pooled analysis (P=0.25, p.26).	None (p.24).	Hand hygiene, combined with facemask usage, reduced contagion risk by 22% according to pooled analysis (P=0.25, p.26).	Very low level of evidence (p.58). "One study found that sleeping in a small group reduced the transmission of influenza compared with sleeping in one large hall." (p.58)
Evaluation of mechanic plausibility	"There is mechanistic plausibility for the potential effectiveness of this measure" (p. 27).	"there is mechanistic plausibility for the potential effectiveness of this measure" (p.25)	"Theoretically, hand hygiene could prevent influenza transmission." (p. 21).	(No evaluation of mechanic plausibility was performed)
Potential harms and side-effects	"There might be issues with allergies in some individuals, and prolonged use of face masks can be uncomfortable or inconvenient" (p. 26)	None (p. 24).	"Possible soap and alcohol allergies" (p. 21).	Modification, postponement or cancellation of mass gatherings may have cultural or religious implications (p. 58).

The table shows that WHO was able to formulate recommendations according to the principles of evidence-based medicine and mechanistic plausibility even without statistically significant results from RCT studies (see chapter 5.5). Yet the usage of the mechanistic plausibility argument was very superficial and non-systematic, as is shown by the arguments summarized in the table. This means that WHO did not fully comply with the principles of EBM, which indicate the need for understanding properly the physical mechanisms of infection, in order to develop effective interventions against an epidemic (see chapter 5.5). For example, in the case of "avoiding crowding", WHO did

not give any statement of mechanic plausibility. This may have been caused by the inability of WHO to find a compromise, whether influenza viruses can spread via aerosols or not. The dominant belief in the Western countries was that large cough and sneeze droplets, and contaminated hands spread influenza viruses, whereas the Asian countries believed that viruses are commonly spread also via air and aerosols (see chapter 5.9**Error! Reference source not found.**).

Despite of its minor imperfections, the WHO report of 2019 acts as a relatively good and unbiased benchmark to which we can compare the statements of WHO, CDC and ECDC in spring 2020. The relatively unbiased nature of this report was caused by the fact that WHO published it before the COVID-19 pandemic, without political pressures that later on related to the severe global lack of surgical facemasks.

6.2. ECDC, WHO and CDC during the COVID-19 pandemic

Following the onset of the COVID-19 pandemic, authorities found that the demand for of respirators and surgical masks in healthcare alone is so high that there will not be enough facemasks even for the healthcare workers.§§§§§ This notion gave rise to a new political argumentation line, according to which "*there is no proof of the benefits of facemasks*" and "*the masks should be reserved for healthcare workers*" (see chapter 5.4). This new mask-sceptic argument was then elaborated with all the possible harms, limitations and doubts that could be related to facemasks, including some hypothetical harms that had no connection to empirical evidence (see chapter 3). A good example of this extended mask-sceptic argumentation line is found in the facemask report of ECDC (2020b), which summarizes in its pages 2–3, why facemask usage cannot be recommended to healthy, asymptotic persons.

In the beginning of 2020, also WHO changed its recommendations and started to emphasize the need for "rational usage of facemasks", meaning the prioritized reservation of facemasks mainly for healthcare workers and for symptomatic COVID-19 patients (WHO 2020a). WHO highlighted this change of recommendations by removing facemasks from its list of the "best ways to protect yourself against the pandemic" (WHO 2020b), although facemasks had still been mentioned in that list in the beginning of 2020. According to the new recommendations, the best ways to protect oneself from COVID-19 were *cough and sneezing etiquette, hand hygiene and keeping a safety distance of at least 1 meter to other people*. In its new recommendations and information bulletins, WHO also emphasized how difficult the usage of facemasks is for everybody else except for the professional healthcare workers (WHO 2020b). These new recommendations no longer had any logical or scientific connection to the WHO report of 2019, which considered the pro-facemask evidence equally strong as the pro-hand-

§§§§§ The decision was probably based on calculations (e.g. Wua et al. 2020) that showed that although China is the world's largest manufacturer of facemasks, the masks produced in China would still not be enough even for the Chinese, if all citizens were recommended to use masks during a pandemic.

hygiene evidence, and notably stronger than the evidence that existed in favor of social distancing or "cough and sneezing etiquette".

When the news of the severe, international lack of facemasks reached USA, the CDC first reacted based on the bureaucratic discourse, regulation discourse and Cochrane paradigm. They tried to repeat to the citizens the new instructions of WHO, according to which 1) facemasks are useless for citizens, 2) best protective measures for citizens are hand hygiene, cough and sneeze etiquette and avoiding of crowds and 3) the facemasks must be reserved for the healthcare workers (CDC 2020). All these argumentation lines culminated in the tweet of US Surgeon general (2020), stating

> *"Seriously people – STOP BUYING MASKS! They are NOT effective in preventing general public from catching #Coronavirus, but if healthcare providers can't get them to care for sick patients, it puts them and our communities at risk!"*

This message summarized the same message that WHO, ECDC and CDC had been distributing in other parts of the world, but this time the logical fallacy of the message was more obvious. It was not difficult for the American media to notice that US Surgeon general was actually stating "*Do not buy facemasks, because they are so valuable protective devices that they should be reserved for healthcare workers only*". The discovery of the manipulative and fallacious nature of Surgeon General's message caused strong reactions in the media (e.g. Bentley 2020-04-02), and authorities had to change their approach to facemasks, as is explained in the article of Jingnan, Aubrey and Wroth (2020). Although the protective benefits of surgical fiber cloth masks would have supported a recommendation for all citizens to use them, the CDC focused their recommendations on *cloth masks* in order to fight the COVID-19 epidemic, and in order to help reserve the surgical masks for healthcare workers (CDC 2020).

The new conclusion of CDC was somewhat surprising as it was not compatible with the Western facemask discourses, which tended to consider cloth masks as somewhat retarded (see chapter 5.9). Neither was the recommendation of CDC compatible with the discourses of bureaucracy, standardization, and regulation (see chapter 5.6). This example shows that sometimes the historical, cultural and political discourses and argumentation lines are stronger than the scientific, quasi-scientific and bureaucratic discourses. A potential factor in the radical change of opinion within CDC may also be the fact that president Trump spoke openly of the potential benefits of cloth mask usage (see Jingnan, Aubrey and Wroth 2020).

After the CDC changed its recommendations to facemask-positive in early April 2020, also the WHO changed its instructions and communication concerning the widespread use of masks by citizens. For example, the WHO removed from its website its list (WHO 2020b) that did not mention facemasks among the best protective measures against COVID-19. This list was replaced by a recommendation that all people should wear facemasks if they cough or sneeze (WHO 2020c). This, however, was only a cosmetic change of facemask recommendations. A notably bigger change occurred in May 2020, when Chu et al., funded by WHO, published the results of their massively large

literature study concerning the benefits of facemasks (Chu et al. 2020). Based on its findings, WHO issued a revised recommendation stating that all people over the age of 60 should wear a surgical mask in crowded areas or on public transport, while a cloth mask was recommended for other citizens (Guardian 2020). Later on, the WHO changed the recommendation to a more general form, indirectly suggesting that everybody can choose whether to use a surgical mask or a cloth mask (WHO 2020-12-01).

6.3. Explaining the differences between CDC and Finland

CDC and the Finnish ministry of health (STM) had an extremely big difference in their recommendations on the time interval from March to August 2020. While CDC recommended cloth masks to all Americans, the Finnish health bureaucracies FIOH, Tukes and Fimea emphasized that cloth masks offer no protection to their wearer, and that even surgical facemasks should not be called protective equipment, as they do not protect their wearer (FIOH 2020). This difference of recommendations is made even more visible by the fact that some Finnish schools prohibited facemask usage in May 2020, and still in August 2020, a major grocery store prohibited facemask usage from its employees (see chapter 5.1). Theoretically, Finland and USA should both be modern Western countries that base their decisions on the best available scientific evidence. In practice, however, the highly different history and culture of these two countries led Finland and USA to react very differently to the lack of surgical facemasks in spring 2020.

USA was born in an uprising of the Americans against the government of the British Empire. The constitution of the new country gave a high level of freedom for its citizens to act against the potential tyranny and excessive control exercised by the government. As a result, USA has a strong tradition of suspicion against the federal government and authorities. The culture of the country is also affected by the widespread *pioneer discourse*, which emphasizes the need for every family to be able to handle problems independently. A more radical version of this discourse is the *survivalist discourse*, according to which citizens must not rely on the state's ability to deal with citizens' problems, and instead, each family must prepare independently for all possible crisis conditions. All these traditions and discourses encourage citizens to be active in the procurement of protective equipment, and if industrially manufactured protective equipment is not available in the store, citizens should make the protective equipment themselves following the tradition of the *DIY discourse* (do-it-yourself). When applied to the COVID-19 pandemic and facemasks, these US discourses acted as a motivator for all families to protect themselves with facemasks – either industrially produced, or self-made.

Finland, on the other hand, belonged first 600 years to Sweden, which developed an effective public administration system already in the 16th century. This bureaucracy was so highly organized, reliable and uncorrupted that people learned to trust it, or were convinced to trust it and obey it. The rulers of this state bureaucracy perceived the subjects of government as uneducated, untrustworthy and potentially too proactive,

meaning that the patronization of citizens was required, for example, to make sure that Finns would not start working for their national independence. This patronizing attitude of the government did not change year 1809, when Sweden lost Finland to Russia, as now it were the Russians who felt the need to monitor and patronize the Finns. Although Finland gained independence from Russia year 1917, the two wars that Finland lost against Soviet Union years 1939 and 1940–1944 led again to a situation in which the Finns had to quietly obey the authorities, their government, and the external Soviet influencers. Although the Soviet Union collapsed, and Finns could have gained more political liberties in the 1990's, the decision of Finland to join the European Union 1994 started a new era of obedience. It was in the interests of Finland to integrate to EU as much as possible, in order to get as far away from Russia as possible, in a geopolitical sense. This yearning to be fully integrated with EU led to a common practice to avoid any conflict with EU regulations and recommendations. During the COVID-19 pandemic, the Finnish authorities needed to comply with the recommendations of ECDC completely and without any doubt.

The long tradition of the Swedish state bureaucracy in Finland, together with the exclusion of all market economy oriented right wing parties from the Finnish government, led to the strong influence of the bureaucratic and regulation discourses in Finland 1960– 1990. Although these discourses were also partially influential in USA (e.g. in the FDA and CDC), the total effect of the bureaucratic and regulation discourses was smaller in USA, as it was balanced with the market oriented and more individualistic discourses of the conservative party. In addition, the pioneer, survivalist and DIY discourses were much stronger in USA than in Finland.

USA and all European countries had the same alternatives in spring 2020 to react to the COVID-19 pandemic and to the serious lack of respirators and surgical masks. It was basically possible to

1. tell the people that facemasks are difficult to use and their benefits are very small or non-existent (in order to discourage people from using facemasks)
2. tell the people that they should use cloth masks and even prepare cloth-masks by themselves (to reduce the demand of surgical masks among consumers and to help reserve surgical masks to healthcare professionals)

Due to historical and cultural reasons, Finland chose alternative one, while USA chose the second alternative. Due to the high popularity of the bureaucratic discourse in Finland, it was still very difficult for the Finnish authorities to admit in the fall 2020, that their decisions and recommendations about facemasks had not been based in scientific reasoning in spring 2020. Authorities tried to claim that the changes in recommendations in August 2020 were based on newly found scientific evidence about the benefits of facemasks – not on the fact that finally in August 2020 the Finnish enterprises were able to produce enough surgical facemasks to meet the demand of the Finnish people. Within the bureaucratic discourse, there is no tradition of admitting

that authorities might have made errors or could have possibly manipulated the truth for the best interest of the nation.

7. Summary and conclusions

Benefits and harms of facemasks

The benefits of facemasks are based on their capacity to filter virus aerosols that carry viruses like SARS-CoV-2. The best surgical masks filter over 95% of the virus aerosols of the size 3 microns (0,003 mm), while the best woven cloth masks reach the level of 60–74% with particles of 0.02–3 microns, without yet preventing the breathing too much (chapter 2.3). Out of the cloth masks, the cotton-polyester masks seem to have the best filtration capacity. Micro fiber masks, also, have a high filtration efficiency, but they tend to cause a bigger breathing resistance than a cotton-polyester mixture mask of the same filtration efficiency.

The high economic and ecological cost of disposable masks can be avoided by using washable cloth masks. When cleaning facemasks, the high concentration of soap is more crucial than a high temperature. First laboratory tests have also shown that surgical fiber cloth masks (made with the melt-blown technology) actually do tolerate about 10 washes, before their filtering capacity is lowered below the level of most woven cloth masks (Harlin, Salo & Kulmala 2020).

Several meta-studies of former RCT studies about mask usage have been performed. Most significant was the study of Chu et al. (2020), which found statistically significant benefits of facemask usage. These benefits had already earlier been discovered by the meta-study of Jefferson et al (2011) and Barasheed et al. (2016), although to a lesser extent. The population level benefits of facemask usage are also indicated by the country-to-country statistics, according to which COVID-19 mortality has been substantially higher on those countries, where frequency of mask usage was low during the first 100 days of the epidemic. This statistical conclusion holds, even if other country specific variables are taken into account in the statistical analysis (Cheng et al. 2020).

It is important to evaluate the benefits of facemasks with sensitivity to context, avoiding statements like "*cloth masks do not protect their wearer*". Although this statement could be reasonable in the context of a hospital, where healthcare professionals need a high degree of personal protection, the statement is misleading when applied to people who just briefly visit a grocery store. All types of masks protect their wearer, at least to some extent. This is analogical to social distancing: 1 meter will give some protection, 2 meters will give a bit more, and 8 meters of distance is already relatively safe, unless the exposure is long lasting and the virus is being spread by a super spreader or by a person, who is shouting, singing, or performing heavy physical exercise. By combining facemask usage, social distancing and good ventilation, it is possible to reduce the risk of contagion significantly.

An interesting tentative conclusion, revealed by observational studies, is that facemasks may reduce the severity of the COVID-19 disease, even if the mask does not

prevent the infection fully. In the Diamond Princess cruiser, facemasks were not used and 80% of infected passengers developed symptoms, whereas in the Ernest Shackleton cruiser facemasks were obligatory and only 20% of the carriers of the virus developed symptoms (chapter 2.1).

There is no evidence of serious harms of facemasks to their wearer in normal settings, although mask usage has been studied in dozens of scientific studies during the last 100 years. The most significant harms seem to relate to the long-lasting usage of the N95 / FFP respirators, and the reported harms have been mostly discomfort and headaches. The harms of surgical facemasks and cloth masks tend to be smaller, as they cause less resistance to airflow, and are not fastened so tightly to the face with elastic band.

The degeneration of scientific information by public authorities

The social scientific part of the study applied memetic discourse analysis for creating a model for the degeneration of scientific information to misleading statements, false beliefs and bizarre policies. The starting point of the work was the idea that scientific information and human knowledge in general, tend to break down to small pieces of simplified, popular and unscientific knowledge elements i.e. *memes* (Dawkins 1976) or *discursive elements* (Habermas 1984). These memes are then distributed and mutated in a complicated network of scientists, international organizations, national organizations, experts, journalists, politicians and citizens. Memes are not only carried by human and organizational actors, but also by discourses and ideologies, which can be perceived as interactive systems that evolve by adopting new memes, exchanging memes with allied discourses, and by making ad-hoc changes to their peripheral memes (see 5.2). Based on the theory of memetics (Malmi 1988/1992/2009) and the theory of cognitive dissonance (Festinger 1957), the most successful memes in cultural evolution are the attractive and simple memes that are coherent with popular discourses, paradigms and ideologies – not the ones that are epistemologically the most correct or true ones.

The usability of this frame of reference was tested in a hermeneutic study, which started by identifying the public authorities that had published influential statements, press releases or recommendations, which had then indirectly led to the fact that some Finnish schools and grocery stores prohibited mask usage from their employees in May–August 2020. The central actors and memetic mutation processes are summarized in the figure below with red arrows.

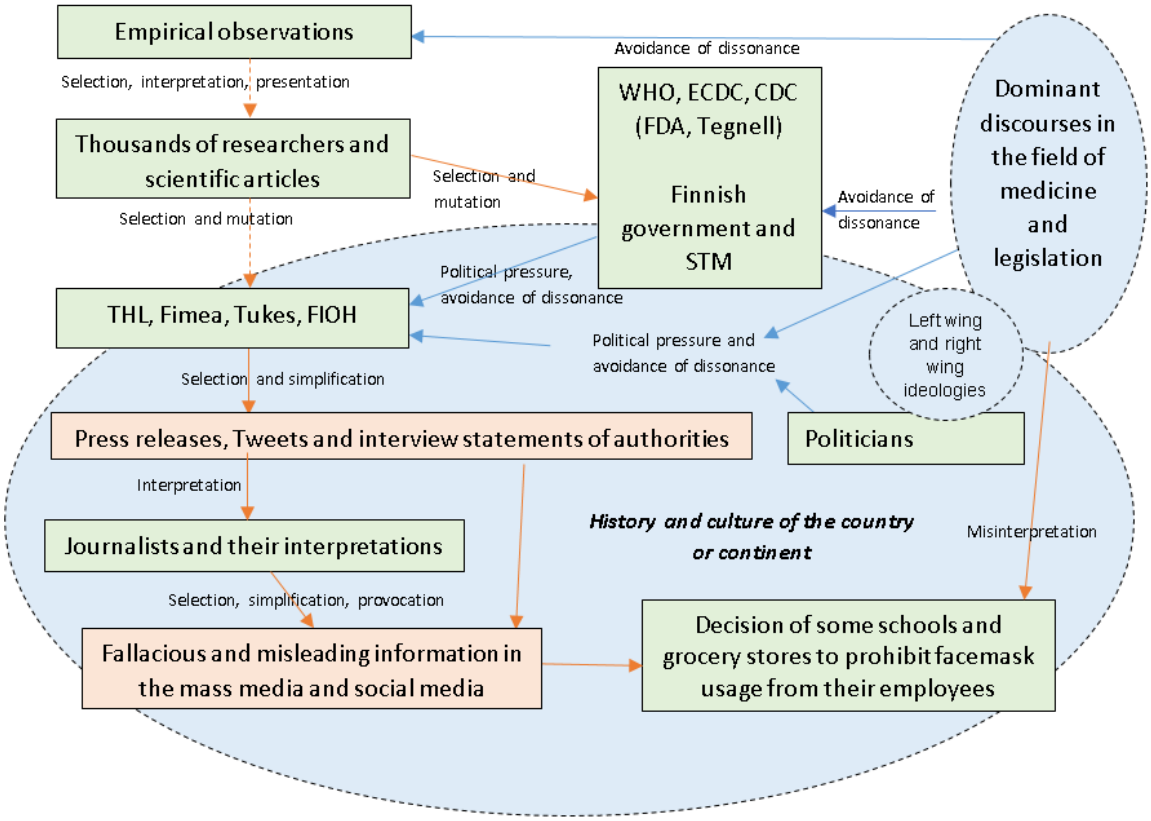

Figure 8: The degeneration of scientific knowledge in WHO, ECDC, STM, THL, Fimea, Tukes and FIOH

The central misleading or fallacious conclusions produced by this communication network were the following:

1) "*The benefits of facemasks are minor or non-existent*" (influenced by STM 2020b).
2) "*The usage of facemasks is difficult and the inability of people to use facemasks properly may increase the risks of infection*" (influenced by ECDC 2020),
3) *Especially the cloth masks can be dangerous as they may cumulate germs in front of mouth and nasal passages* (influenced by ECDC 2020).

The fallacy of these memes is explained in chapters 2, 3 and 5.10 of the report. Yet, public authorities used them, as rhetoric support to their decision of not recommend facemasks. The main reason for not recommending facemasks was the political argument, according to which *there is lack of surgical masks and therefore, the masks must be reserved to the protection of healthcare workers*. The combined effect of these arguments was the meme "*facemasks cannot be recommended*", which then mutated to the form "*authorities recommend against facemask usage*" in the media.

The totality of the different facemask negative arguments, documented in this study, is summarized to Figure 9, which also connects memes to discourses, and discourses to historical movements and ideologies.

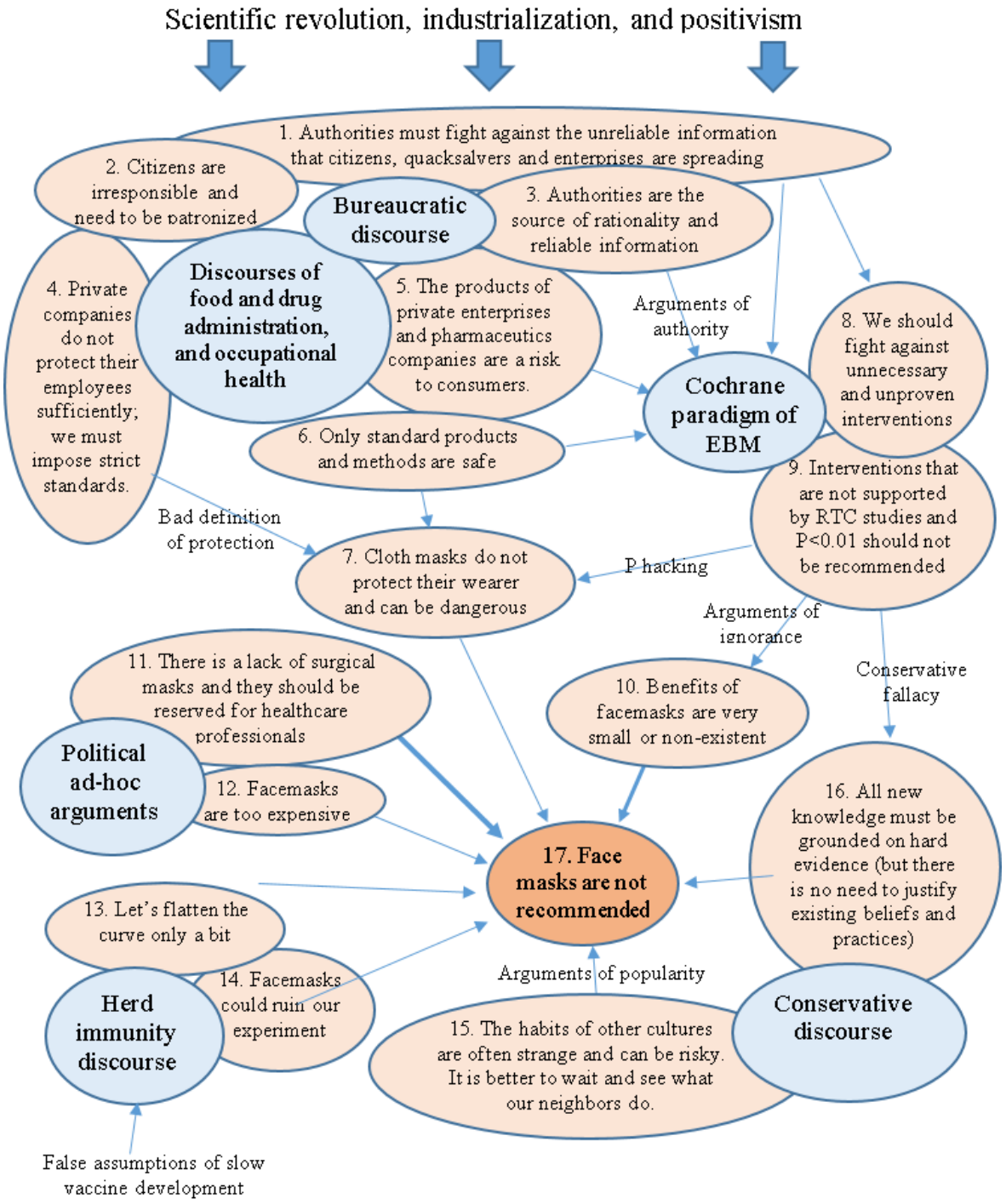

Figure 9: The discourses and memes against facemasks

From a methodological point of view, this diagram is a narrative that intends to interpret the historical developments that led to the prohibition of facemasks in some Finnish schools and grocery stores. As the diagram was created with a heuristic and hermeneutic method, it acts as an explanation for the observations, and as a hypothesis for future research. For example, it would be interesting to see, whether these discourses and memes were used for promoting similar facemask-sceptic conclusions in other countries as well. In addition, it could be useful to analyze more closely the causal effect of the rhetoric connection between two discourses, possibly by interviewing some of the central decision makers, or by using various methods of intertextual discourse analysis (see Fair.

What could we learn from decision-making theory, EBM, and WHO?

While the Cochrane paradigm is a collection of biased and exaggerated memes that tend to lead to logical fallacies, the theory of EBM (evidence-based medicine) is actually a powerful tool for healthcare authorities for making rational decisions (see chapter 5.5). It is also perfectly in line with the general theories of decision-making, which emphasize the need of rational decision makers to be able to make decisions also based on impartial and uncertain information, without waiting for more empirical evidence. While CDC and ECDC have failed to comply with the principles of the theory of EBM to some extent, WHO seems to have applied the theory of decision-making and EBM in a relatively consistent manner, at least, before year 2020.

Below is a list of some main principles of the theory of EBM, and decision-making theory, to which healthcare authorities should pay attention:

Be scientific: This means that authorities should be logical, ethical, transparent and open to criticism. Being logical means avoiding the common fallacies listed in Figure 9 and chapter 5.10. In order to do so, it would be important to understand, what makes the Cochrane paradigm so misleading and dangerous (chapter 5.5). Being ethical means careful examination of your references, to see whether the results were produced by P hacking or by other ways for misinterpreting the results. It also means that scientific and political argumentation should be kept separate from each other, which was not the case with WHO, ECDC and STM in spring 2020. Being transparent means the authorities should open up of all arguments to their components, and present good scientific references, to support each component avoiding the fallacy of "argument from bureaucracy" (chapter 5.10). This may be difficult for authorities like STM and THL, who seem to have a tradition of providing only a minimal number of scientific references in their reports. Being open to criticism means, that bureaucracies should give good scientific references and humbly accept that the large mass of educated citizens is then able to review the quality of the arguments, sometimes also being able to point out errors in the reasoning of the public authorities.

Engage a multidisciplinary team of scientists: University trained professionals of medicine should avoid argumentation from the position of "medical authority". Instead, they should accept that doctors of technology understand aerosols, ventilation and filtration better than physicians do, and that the doctors of administration probably

know more of rational decision-making, in general. COVID-19 has shown that multidisciplinary teams produce a better understanding of phenomena that have a technological, economic, social, cultural, administrative and political dimension. Without engaging a multidisciplinary team, it is difficult for physicians to analyze the mechanical, biological, cognitive, social and cultural economic causalities relating to non-pharmaceutical interventions like facemasks.

Learn to make decisions under uncertainty and lack of information: According to EBM and decision-making theory, one should be able to make a rational selection between "intervention" and "no intervention" even when faced with lack of statistically significant evidence, based only on models of mechanical, chemical and biological causality. For example, when Mesny died 1910 for plague that was transmitted via air, the sample size was only one person, and yet the scientific community realized that diseases could be infected via air (chapter 5.9). When A.I. Virtanen invented the Molotov cocktails 1939, there was no scientific evidence that they could offer protection against tanks or that they would be safe for their users. Yet, the Finnish soldiers used them successfully as "protective equipment" against the Soviet tanks. This kind of rapid decision-making-under uncertainty can be extremely difficult for people who have made their career in bureaucracies for occupational health or food administration, as the mission of these bureaucracies has usually been to fight against uncertain information – not to use it. Without a training for rapid and yet rational decisions under uncertainty, public authorities are likely to fall into decision paralysis (inability to make any decision), argument from bureaucracy, argument of ignorance, conservative fallacy, and argument of popularity, when they are interviewed by the media (see chapter 5.10).

Engaging the wide audience and swarm intelligence: During the initial stages of the COVID-19 pandemic, the first comprehensive reports of the usefulness of the facemasks were not created by doctors of medicine or by healthcare organizations. Instead, a large group of volunteers, coordinated by a Bachelor of Arts, created them (Howard et al 2020). This means the authorities might learn to appreciate, that all best scientific information is currently available on the Internet, and that the knowledge of any single healthcare authority is very limited compared to this mass of freely available knowledge. Authorities should also consider that the best quality investigations might not be done by highly skilled individuals, who have an impressing CV, but by a large number of volunteers who can handle much more information than just one single researcher or traditional research group (e.g. Bellingcat).

Let your customers set the KPI's: According to EBM and decision-making science, rational decision makers should try to find the solution that optimizes the KPI's that have been defined by the customer, under the constraints given by the customer. This means that customer values should be given more importance than traditionally has happened in the Cochrane reviews (chapter 5.5). Customers, for example, should be included in the evaluation of risks and moral issues. This could mean, for example, providing an easy way for large amounts of people to sign in to RCT studies concerning the benefits and risks of some experimental treatments like new vaccines.

Learn to understand communication and memetic mutations: Authorities should understand the mechanisms by which scientific knowledge deteriorates, when it passes through the network of authorities, politicians, reporters and social media. They should avoid stating "*we do not recommend X because there is not enough evidence to recommend X*", since this meme is likely to be mutated to the meme "*authorities do not recommend X*" or even to meme "*authorities recommend against X*" (chapter 5.5). Instead, it would be better to present the evidence for intervention X and the evidence against doing it. That would give more transparency to the decision-making situation, and allow people to see, which is better: "intervention X" or "no intervention X".

Continuous improvement: According to EBM, external reviewers and auditors should continuously review the practices and processes of EBM, in order to improve EBM. This means that the Cochrane Community should welcome also criticism that comes from the outside of the medical professions. Although EBM is already a very good frame of reference, external influence might be needed for showing the points, where the healthy forms of EBM differ from the more biased and fallacious forms of the Cochrane paradigm. The idea of continuous improvement could possibly be applied also to the life-long-learning of healthcare authorities. It seems that the persons who learned discursive elements of the Cochrane paradigm in the 1980's might benefit from some additional training to the newest developments in the Cochrane Reviewer's Handbook.

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Dependencies

The main author Dr. Pasi Malmi works in Dassault Systèmes, which makes COVID-19-simulations with the Simulia product and 3D modeling of the SARS-CoV-2 virus with the Biovia product. Dassault Systèmes, however, does not produce facemasks, respirators or COVID-19 related equipment.

Vesa Kirjavainen works in HUS as a hospital microbiologist, with no conflict of interest.

Other writers of the report do not have any relevant dependencies.

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Appendix: Detailed tables

The rows 1–5 show the number of references that were reviewed in the original scope of the literature study. Rows 6–9 show additional references that were discovered, as the study advanced. The maintenance of the statistics, shown in the table, was stopped in June 2020, when the first preprint version of the report was published.

Appendix table 1: Sources of the literature study and other references

	Provider of information	Scientific references	Facemask related references	References relevant for cloth masks
1	Institute of Medicine and FDA (2006)	2	2	0
2	STM (2012)	24	5	0
3	WHO (2019)	241	10	0
4	ECDC (2020 March)	6	3	2
5	ECDC (2020 April)	27	7	5
6	Howard et al. (2020) and Jefferson et al. (2011)	96	52	7
7	Brosseau and Sietsema 2020	52	29	18
8	References received from other writers of the report after the first draft of this report	38	31	4
9	STM 2020	8	8	0

Appendix table 2: CRI and ILI attack rates among the users of medical masks and cloth masks (based on MacIntyre et al. 2015)

	Medical mask arm	Cloth mask arm
Subjects in the arm	580	569
Patients of clinically diagnosed respiratory illness CRI (excluding ILI)	28	43
Patients with laboratory confirmed virus (including ILI and CRI influenza)	20	31
Patients of Influenza Like Illness ILI (excluding CRI)	1	13
CRI and ILI, total	**49**	**87**
Attack rate – clinical respiratory illness	4.8 %	7.6 %
Attack rate – laboratory confirmed virus	3.5 %	5.4 %
Attack rate - other ILI, self-reported	0.2 %	2.3 %
CRI and ILI, total	**8.4 %**	**15.3 %**

Appendix table 3: Concentration of the risk factors to the cloth mask arm (based on MacIntyre et al. 2015)

	Surgical mask arm	Cloth mask arm
Sex, male	19.3%	23.4%
Age	36	35
Smoker	13.4%	13.9%
Former respiratory disease	11.4%	12.3%
Vaccinated against influenza	3.6%	3.7%
Hand washing, times per day	14	11
Number of contacts, median (with minimum and maximum values presented in parentheses)	21 (0–540)	21 (0–661)

The cloth mask arm had notably more males, smokers and test subjects with former respiratory diseases, and washed their hands notably fewer times per day than subjects in the surgical mask arm. The maximum number of daily contacts was also notably higher in the cloth mask arm. MacIntyre et al (2015) reported the "normal" age of the test subject groups (arms) with an average, while the number of contacts was reported with median. No explanation was given to this decision. A possible cause for using median for the number of contacts is that average would have shown that the cloth mask arm had notably more contacts per day than the surgical mask arm. Suggestive evidence for this is shown by the fact that the maximum value of contacts was notably higher in the cloth mask group.