Pandemics and intergenerational justice. Vaccination and the wellbeing of future societies. FRFG policy paper

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Summary
Has the world responded to the coronavirus pandemic in an intergenerationally just manner? Three aspects are relevant to intergenerational justice: the number of dead and ill (medical dimension), the economic downturn (economic dimension), and the additional national debt (financial dimension). The goal must be to protect future societies from the cumulative damage that pandemics may cause. Against this background, a new vaccination strategy for humanity – and this includes the individual national states – turns out to be the most important element. Such a strategy would help to ease the diseases we can ease and eradicate the diseases we can eradicate. Herd immunity should not only be the goal for the rich countries but for humanity as a whole. This is not only necessary for social and/or developmental reasons, but also serves the self-protection of the richer countries in an interconnected world.
We need more government funding for prophylactic vaccine research. This would lead to the typical development time of a vaccine – 10-12 years on average – being shortened. The rapid development of vaccines against SARS-CoV-2 shows that a reduction to 1-2 years is possible if the necessary resources are made available. The testing of vaccine candidates for each infectious disease, however, comes with the cost of at least in the high three-digit million euro range. Profit-oriented companies cannot reasonably be expected to produce vaccines in advance that may never be needed at their own expense. In the future, vaccines must therefore be treated as "global public goods", whose development and production are primarily the responsibility of states. The record amounts pledged by governments at the donor conferences for vaccines in 2020/2021 show the beginning of a paradigm shift.
However, this approach will come to nothing if the willingness of individuals to be vaccinated does not increase at the same time, as well. Here, every single member of the current generation has a duty of solidarity towards future generations. This should be made aware of and weighed against self-interest. Responsible epidemiological individual behavior includes regular (repeated) vaccinations for the purpose of prevention. This applies in the context of parental responsibility concerning to child vaccinations, but also for adults, e.g. in the context of an annual influenza vaccination. In doing so, thousands of deaths can be avoided, which for the most part have been tolerated by our society up until now. Two changes of the framework conditions are central to this:

- Vaccinations should be generally free of charge for the entire population.
- Vaccinations should be easily accessible, with only few exceptions. This means that vaccinations should be available not only from doctors but also from pharmacies.

1. Introduction

If intergenerational justice[1] means improving the life chances and living conditions of future generations as far as possible, then its link to epidemics is obvious.[2] After all, epidemics were – and still are, as we are now witnessing in the West – among the apocalyptic horsemen who bring death and suffering to the people (World Economic Forum 2017). We should protect future generations from foreseeable damage if we have the power to do so.
To make this case, we begin by laying out two examples – smallpox and influenza – that are meant to illustrate the significance of epidemics for the fate of mankind. This is followed by a proposal of a new, and broader understanding of the notion of "precaution" which does not only refer to the prevention of future disease or death but also takes into account the effect of the pandemic on other policy dimensions. The ensuing demands with regard to vaccination are addressed to the individual citizen, of whom a change in behaviour is required, and to politicians and lawmakers with regard to better vaccination policies in the future.

2. Pandemics have been a constant companion of mankind

The corona pandemic, which began in China at the end of 2019, has suddenly made people aware of an important aspect of their own existence: micro-organisms are the rulers of our planet with all its ecosystems (Earth Microbiome Project 2020). Microbes (algae, bacteria, parasites, fungi, prions, protists, viruses or viroids) make it into the newspapers especially when they harm us. But there are billions of microbes in every handful of potting soil. They are constantly around us, even inside us. As a biological species, as one species among others, we have had to learn in the course of our own evolutionary history to cope with pathogens well enough so as to not go extinct because of them. But they have always been a threat to our species. "Pathogens, including viruses, are relatively small organisms that eat their prey from within. Infectious diseases may often seem scary and threatening, but under normal conditions they are as natural as lions eating antelope (...)" (Quammen 2013: 8).
For microbes, bodies of animals – or even human bodies[3] – are simply a means to exist and reproduce themselves. To start, we will briefly describe two viruses (or virus families): one that has been completely defeated, and one that is very successful until the present.

2.1 The pox

Smallpox, which is caused by a virus, has been known for thousands of years. The mummy of Pharaoh Ramses V of Egypt shows distinct smallpox scars. Throughout history smallpox has killed hundreds of millions of people, more than any other disease and more than all wars of the 20th century put together (Tucker 2002: 3).

The increasing mobility of mankind has led to the worldwide spread of smallpox since the 15th and 16th centuries. In the 18th century, one in ten children died of smallpox. In 1967, 10-15 million people in 43 countries were still suffering from the disease, and 2 million died of it. Those who survived smallpox were usually disfigured for life by the so-called smallpox scars and one in ten survivors went partially or completely blind.

With the help of vaccinations, mankind has succeeded in eradicating this disease.[4] The world's last case of smallpox was documented in Merka in Somalia in 1977. Since hardly anyone has ever seen a living individual with the deep smallpox scars on their face, the disease, which plagued earlier generations to a degree that seems unimaginable today, has disappeared from public awareness.

2.2 The seasonal influenza

Influenza[5] is a disease that affects approximately 9% of the world's population every year, with up to 3 to 5 million severe cases (Clayville 2011). WHO Europe writes: "During the winter months, seasonal influenza can infect up to 20% of the population, depending on which viruses are circulating, and can cause substantial mortality. A recent study found that worldwide up to 650 000 people die of respiratory diseases linked to seasonal influenza each year, and up to 72 000 of these deaths occur in the WHO European Region."[6] Like the coronavirus (which is not itself an influenza virus), influenza viruses affect the respiratory system and can cause serious respiratory diseases.

Epidemiologists rely on estimated and model values to record the number of deaths directly or indirectly caused by influenza viruses (Buchholz et al. 2016: 523). These estimated values are subject to incomplete and low-quality surveillance. Unlike with SARS-CoV-2, there is no basic obligation to check if a respiratory disease was in fact caused by an influenza virus; and doctors often do not take the influenza diagnosis into account when issuing death certificates. Because of these statistical shortcomings, many experts calculate the deaths attributable to the influenza viruses by relating the monthly data of the Federal Statistical Office on the overall mortality of the population with the data of the influenza working group on the course of the flu epidemic (the so-called excess mortality). The number of deaths due to influenza is calculated as the difference that results when the number of deaths that would have occurred if there had been no influenza wave during that period is subtracted from the number of all deaths occurring during the influenza wave.

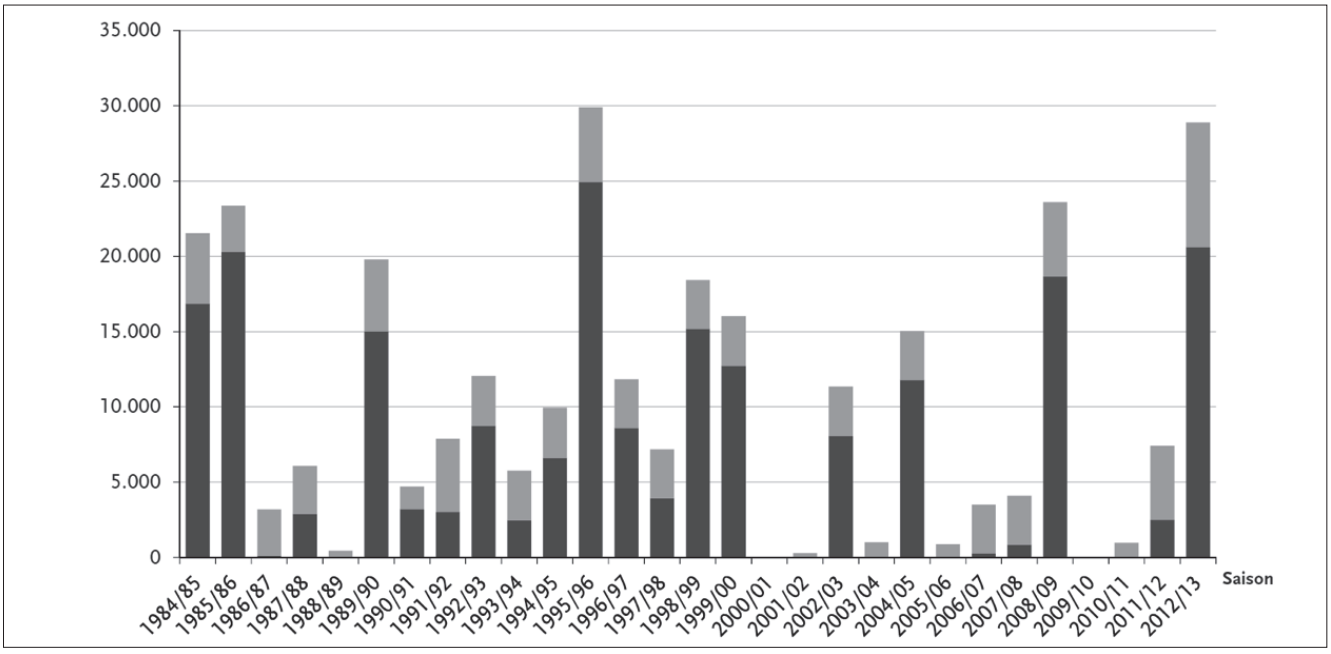
In Germany, for instance, the number of annual flu deaths fluctuates greatly, but has exceeded the 10,000 mark in around half of the years shown in Fig. 1. The highest number of deaths in the past 30 years occurred in 2017/18 – according to estimates by the Robert Koch Institute (2019: 47), this strong flu epidemic cost the lives of around 25,100 people in Germany more than one-quarter of all deaths attributed to COVID-19 until November 2021.

The most deadly variant of an influenza virus was the so-called "Spanish flu" (subtype A/H1N1), which killed around 50 million people worldwide, far more than the First World War (17 million) and around 2 percent of the world population (1.8 billion).

3. What did mankind do differently in 2020/2021 than with earlier pandemics?

It is mainly thanks to the compulsory childhood vaccinations and the spread of penicillin and other antibiotics since the Second World War that we in the West have been able to remove epidemics from the list of life risks we often think about. In Germany, 16.5 times more people now die from the consequences of non-communicable diseases than from infectious diseases (World Health Organization 2014: 175). However, the latter remain a serious threat to the lives and quality of life of the inhab-

Fig. 1: Deaths attributed to influenza in Germany



Source: Robert Koch Institute (2015): Epidemiological Bulletin, No. 3/2015, p. 18. The dark grey bars represent the number of excess deaths attributed to influenza in a conservative calculation, the light grey bar area indicates the probable additional number.

itants of the world's less developed countries. The most serious infectious diseases are tuberculosis (1.2 million deaths per year), AIDS (940,000 deaths per year) and malaria (445,000 deaths per year) (World Health Organization 2019a). Examples of emerging pathogens are the Machupo virus in Bolivia 1962-1964, Lassa in Nigeria (since 1969), Ebola in Zaire and Sudan 1976 and later in West Africa 2014, cholera in Haiti from 2010 and currently in Yemen, Zika 2015 in South America, the avian influenza viruses H5N1 and H7N9 in China/East Asia since 1997, the H1N1 swine flu[7] in Mexico and the US in 2009/2010, and finally SARS (now known as SARS-CoV-1) in Asia in 2002/2003 and MERS in the Middle East in 2012 as earlier variants of the coronavirus that now keeps the world on its toes.[8] In 2019, SARS-CoV-2, which causes the coronavirus disease (COVID-19), was first described. For the first time in decades, a pathogen that was about five to ten times more dangerous[9] than usual seasonal influenza viruses has caused a pandemic in the West, endangering the lives of large numbers of people there.[10]

But how did the response of mankind differ in 2020/2021 when compared to the reaction of our ancestors to earlier pandemics? Earlier generations did not have the knowledge, and therefore also not the words, to bring their precarious relationship with pathogens to the point, but they were much more affected by them than the people of the 21st century. Ironically, the chance that humanity will finally eradicate some of its worst microbial tormentors in the 21st century has not fallen but risen during the corona pandemic.

Until the corona pandemic struck the West, we believed we were invincible. If one had confronted a decision-maker in politics, economics or culture in 2018 with the fact that the global community had set itself the goal of eradicating various infectious diseases, one would have reaped at best a mere shrug of the shoulders. The coronavirus has reminded the Western world of the continuing danger of epidemics and has drawn attention to local and global health management. Never before has the West spent so much money for vaccine development, procurement and distribution. The breakthrough of mRNA vaccines could be a disruptive evolvement of vaccine technology that could have far-reaching consequences for the future. The pandemic has also led to a massive increase in epidemiological knowledge among the population. New hygiene regulations in schools have taught adolescents that microbes are a danger that they must be protected against. Vaccine stockpiling is becoming fashionable again. The risk of not using these prophylactically developed and purchased vaccines is now seen as much smaller than the risk of a lockdown. Podcasts by virologists are echoed throughout society; the opinions of national research institutions/academies of science trigger debates in the mass media. It is a shortcut to say that the corona pandemic has given "experts" more influence. In fact, it has given health experts more influence. There are also experts in the economic, cultural and educational sectors, and they usually speak on talk shows far more often than epidemiologists do. From spring 2020 on, however, epidemiologists and virologists are given more attention. As a result, large sections of the population who had never been interested in epidemiology before now have come to know measures such as "basic reproductive rate", "excess mortality" or "infectivity". We learned that the standard model of disease control states that in the first phase – identifying and extinguishing the source of the fire – infected people must be prevented from infecting others. If this fails, then containment must be achieved. Now one tries to prevent the fire, which no one could extinguish, from becoming too big. Measures include bans on large gatherings, border closures, curfews, general social distancing, and the closure of entertainment, educational and cultural facilities. This can go as far as reducing public life and economic activity to an absolute minimum.[11] Particularly if, as in the case of SARS-CoV-2, a virus can be passed on before the first symptoms of the disease have even appeared, it makes sense to proceed very vigorously at the beginning according to the "hammer and dance" principle (Pueyo 2020a) in order to flatten the first wave as much as possible ("flatten the curve"). Speed is of the utmost importance in disease control. Half of all corona deaths until summer 2020 in the UK could have been avoided if the lockdown had been introduced just one week earlier (Ferguson 2020). In 2021, millions of corona deaths could have been avoided if herd immunity is achieved through vaccination by summer instead of autumn on a worldwide scale.

With regard to the specific virus SARS-CoV-2, the high infectivity was already known shortly after the outbreak in China, but the pathogenicity or lethality was unclear. In such a scenario, it was right to follow the standard model of disease control. Particularly between the first wave and the second wave of infections, when the first shock had faded in summer 2020, ill-conceived slogans such as "hygienism" and "health dictatorship" made the rounds. This polemic was to be expected, as were the far worse conspiracy theories. But still, there are worlds between today and the past. When the plague broke out in Europe in the middle of the 14th century and doctors and authorities of the time had no explanation, the Jews were quickly blamed. They were alleged to have poisoned the wells and thus to have brought the disease into the world. This was followed by the worst pogroms against Jews until the Shoah (Kinet 2020). In many cities, entire Jewish communities were murdered – thousands of men, women and children. There were no comparable corona-related murders in 2020/2021. Unlike in earlier times, people did not follow intuitive thinking that does not recognise complex systemic causes and instead seeks to identify a person (or group of people) as the perpetrator.[12] Or at least less so than before.'[13] The historian Yuval Noah Harari points out another important difference between us today and earlier epochs: "When an epidemic broke out in pre-modern societies like medieval Europe, people naturally feared for their lives and were shocked by the death of their loved ones, but the cultural reaction was resignation. (...) People told themselves it was God's will – or perhaps divine retribution for the sins of mankind: 'God knows best. (...) Those who believe that human beings can overcome this epidemic through their ingenuity only add the sin of vanity to their other crimes. Who are we to thwart God's plans?'" (Harari 2020a).[14] With the scientific revolution, accompanied by a higher standard of education and living, our thinking changed. Whoever calls corona a judgment or a punishment of God is an outsider and today – unlike in the past – will find only a small audience. The increase in knowledge in both science and the wider public since the first quarter of 2020 has been enormous. Science temporarily switched to publishing on preprint servers to share and increase knowledge globally. The public followed (in astonishment) the "trial and error" principle that is the essence of science. Mankind as a whole was able to view the strategies of different countries on the based on, share best practices and estimate,

through simulations, how strongly certain measures would work (and what economic and social side effects they might have).[15] This was swarm intelligence in its purest form. Of course, the methods of data collection were still far from perfect in our present, but if the world's kings had been told 200 years ago that in their future all infections would one day be registered and centrally collected by a World Health Organization, they would have thought it a fairy tale. Never before has humanity's knowledge of epidemics progressed so rapidly, far beyond scientific circles, as with the SARS-CoV2 pandemic.

In sum, an unprecedented pandemic spurred an unprecedented reaction.

4. Vaccination and the standards of living of previous, present and future societies

4.1 The discovery that vaccination can protect against infectious diseases

It is worth remembering that more than any other measure, the development of vaccination methods has helped mankind to escape a number of previously terribly raging infectious diseases. The English physician Edward Jenner had observed that people who had been infected by cowpox could no longer be infected with human-pathogenic (i.e. harmful to humans) pox. Jenner first tested this method in England in 1796 and his scientific publications were published in 1798.[16] The discovery that infections with less dangerous variants of the virus make people immune to the disease led to mass vaccinations in many European countries in the following years and ultimately – 183 years later – to the eradication of smallpox. Jonathan Tucker (2002) sums it up: "The discovery of vaccination marked a turning point in medical history and a fundamental change in humanity's relationship to disease. For the first time, it was possible to take a harmless measure to prevent a deadly infection before it occurred."

As mentioned, smallpox has raged worse than any other infectious disease in human history (Williams 2010), measured by the number of deaths (and disfigured survivors). In theory, people could have effectively protected themselves from the scourge of smallpox much earlier than they did, because cowpox was known and the necessary equipment existed. Many earlier generations could have been spared endless suffering if smallpox had been eradicated earlier than it de facto was. The vaccination procedure is so easy to administer that people could have done it for thousands of years, but the method was only just discovered in the Age of the Enlightenment. It was also crucial that at that time the anti-Enlightenment forces were successfully pushed back. We often take the medical knowledge level of the present for granted, thereby forgetting how difficult it was to overcome false theories. "Every child in the developed world knows that germs cause disease (…) We also know that diseases such as measles, chickenpox and smallpox are infections (…). This understanding has only crystallised during the last hundred years or so. The main opponents were believers in 'miasma theory' (…). Miasmatists were powerful in medicine and society and their stand-off against 'germ theorists' led by Louis Pasteur and the German Robert Koch was bitter and lasted for decades" (Williams 2010: 7).[17]

But gradually, evidence-based approaches became more and more common. In 1966, the World Health Organization (WHO) decided (by a wafer-thin majority of only 2 votes) to launch a 10-year campaign to eradicate smallpox with a budget of $2.4 million. A global campaign to eradicate smallpox was launched – and for the first time, a worldwide compulsory vaccination was introduced, with the well-known result that for the first and so far only time mankind succeeded in getting rid of an infectious disease. As vaccination rates in Europe were sufficient to prevent pandemics, the blessings of Jenner's discovery soon no longer played a role in the public perception of Western societies. Since this milestone in the history of vaccination is no longer in the public awareness, however, only one side of the risk-benefit balance was looked at in the last 30 years: the risks. The formula "In vaccination decisions, the benefits must clearly outweigh the risks" was replaced by "In vaccination decisions, we don't accept any risks at all".

Today, we realise that only mass immunisation against SARS-CoV-2 will restore the life we once led (Gates 2020). We need to regain awareness of where humanity would be today without the discovery of vaccinations and that a lack of commitment in this area threatens the well-being of future generations. But before we can draw any specific conclusions from this change in awareness, let us first say a few words about what humanity can do about infectious diseases.

4.2 Which diseases can be eradicated by vaccination and which not

From an ethical point of view, we would be doing future generations a great service by preparing for coming pandemics. But this implies ability. We humans will never be able to eliminate all pathogens because we can only eliminate those microbes that only occur in humans, i.e. not in wild animals (Wildermuth 2020). Since about 60 percent of viruses alone are also found in animals, and two-thirds of these live in wild animals (Shah 2020), we cannot completely identify the virus carriers and then vaccinate them.

Certain microbes have been circulating in all animal organisms for millions of years without causing any damage. For example, around 3,200 coronaviruses live in bats (Shah 2017). Their immune system is adapted to this. Our human immune system is not. Zoonosis is the technical term for the process when a pathogen passes from an animal to a human being and establishes itself there (i.e. is not immediately eliminated by the human immune system).[18] To infect a new host, a virus must overcome several barriers: (a) it must be able to physically enter the cells of the new host and (b) it must bypass the host's immune system to the extent that cell infection and replication is possible. Since a virus cannot adapt in a targeted manner, the new characteristics that the virus needs are created by random changes in its genome (Thal 2020).

All influenza virus types, all coronavirus types, the pathogens causing AIDS, Ebola, hepatitis E and most other infectious diseases are viral zoonoses. Bacterial zoonoses, on the other hand, are, for example, the causative agents of plague, borreliosis, anthrax or tuberculosis. According to the *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (IPBES), infectious diseases that are transmitted from infected animals to humans by vectors[19] such as mosquitoes, ticks or fleas cause hundreds of thousands of deaths worldwide every year (IPBES 2019: 22).

A further increase in zoonoses is expected in the future (Shah 2017; Renn / Kuhlmann 2020). The reasons for an increased spread of zoonotic agents stem from humans themselves. Changed conditions in food production (think of "mass animal farming") and nutrition

promote the spread of the pathogens (Alpers et al. 2004: 624). For example, the falling costs of long-distance travel have made business trips and holidays to remote (tropical) regions increasingly popular. If a highly infectious pathogen appears in a city in the world, one can be fairly certain that it will soon appear in all cities that are connected to this city by direct flights. Another source for zoonoses are wet markets in which animals that normally do not come together in nature are brought together by humans. At these markets, living animals are offered for sale, slaughtered on site and then sold in portions. It is striking that several pandemics have had their origin in wet markets in China. After the first SARS pandemic, experts warned that the large number of coronaviruses in bats together with the consumption of "exotic mammals in southern China is a time bomb" (Cheng et al. 2007: 683). The current corona crisis also began at such a wildlife market, the Wuhan South China Seafood Market. Apart from the fact that it is difficult to distinguish illegally hunted animals from those from legal farms, stacked cages with different species generally pose an excessively high risk of disease. In all countries where such wildlife markets exist, they should therefore be banned by the authorities as soon as possible.[20]

Of course, climatic conditions and the availability of cold storage also play a role, but much more could be done to eliminate these markets. Trade of wild animals, both legal and illegal, also contributes to the increase in zoonoses. The turnover of the illegal wildlife trade is estimated at 24 billion euros per year (Tröster 2020) and plays a major role, especially in Asia. In order to prevent the spread of microbes or pathogens from wild animals to humans in the future, trade in wild animals should be regulated much more strictly than at present in the interest of global health. The Western countries should generally prohibit the import of exotic animal species, even if they are not threatened with extinction. Exotic animals can be admired as part of eco-tourism, at the zoo or on television, but no one has to have them in one's living room. The desire to have exotic pets increases the likelihood of contact with infected animals and vectors.

Designating nature reserves would also be an effective contribution to disease control. As a result of population growth and intensive land use, humans are increasingly invading areas where other species have lived undisturbed until now. Habitat encroachment, biodiversity loss and ecosystem disruption make viruses from animals much more likely to spread to humans (Shield 2020).

5. Epidemiological imperatives – a different perspective on human rights and duties

Sonia Shah, a disease researcher, explains: "What makes it really frustrating to write about these diseases for so many years is that things never change enough afterwards" (Shah 2013). Mankind must act differently after the coronavirus. It must take precautions to ensure that epidemics are less likely to develop into pandemics in the future.

To do this, it is first of all necessary to learn the epidemiological perspective – the way of thinking of a responsible and solidary individual facing the task of preventing an outbreak of epidemics in a community. This view is at odds with our thinking as self-centred individuals, as whom we legitimately see ourselves first and foremost as bearers of rights (civil rights, liberties, etc.). However, with a contagious infectious disease, we ourselves can unintentionally become a deadly risk to our fellow human beings from one day to the next.

It is as if John or Jane Smith suddenly (unintentionally, of course) hold an arm chest with poisonous arrows in their hands, which fires at other people here and there without any action on their part. Based on this logic, one probably arrives at different conclusions than if one bases one's considerations exclusively on the premise of unrestricted personal liberty rights. If all individuals were to behave in solidarity and refrain from contact with pathogens that could infect their fellow human beings, with or without symptoms of their own, then state measures restricting freedom would be unnecessary. In accordance with Kant's Categorical Imperative, individuals can set up epidemic policy imperatives: this would include, for example, immediately informing the public health department if one detects symptoms of a readily transmissible infectious disease in oneself,[21] compiling a list of all contact persons and going into quarantine, or not giving false information on the forms in restaurants or cinemas etc..[22] However, the call for self-responsibility requires clear recommendations from public authorities. Recommendations are not binding regulations. The extent to which the state is entitled or obliged to take even harsh coercive measures to combat very dangerous pathogens is a difficult topic currently being debated (in governments, in courts, in the public). In any case, the most ethically unproblematic measure is prevention.

6. A more comprehensive understanding of prevention

During the lockdown the phrase could often be heard: "There is no glory in prevention!" The phrase served as a justification for drastic lockdowns. However, the concept of prevention has been interpreted rather one-sidedly by epidemiologists in connection with SARS-CoV-2. The notion of prevention must not only refer to the avoidance of illness or death, but must also take into account other policy dimensions. A balance sheet of how well or badly states have coped with the epidemic in terms of intergenerational justice must include collateral damage. If a state produces immense economic damage (including a shrinking of the wage bill) through a drastic lockdown and robs a substantial part of the population of its livelihood, it may have prevented pandemic-related illness or death, but it has not "taken precautions". The same is true for states that have gone into massive debt in order to avoid the other two losses – medical and economic. They unload the costs of avoiding health-related harm in the present on future generations, who will have to pay back these financial debts.

A (fictitious) world society that has taken preventive action in this comprehensive sense against SARS-CoV-2 would perform well in all three dimensions: the disease does not break out in the first place, so there is no economic slump and no increase in public debt to artificially buy short term economic growth. If we eradicate an infectious disease (or the pathogen that causes it), future generations will have to suffer neither death nor illness as a result of this pathogen, nor economic downturns due to a lockdown as needed in 2020/21 to avoid deaths or illnesses, nor the massive new debt needed in the following years to cushion the economic downturn. This is precisely how things have played out, up until now, with smallpox. Thanks to the actions of previous generations, today's generation of people has neither smallpox deaths nor collateral damage. This lack of collateral damage is not visible and therefore not conscious.

When the threat of SARS-CoV-2 was not yet well understood, the disease control measures imposed by many governments at the beginning of the pandemic were justifiable. The imposed lockdowns (including the suspension of civil rights, closures of busi-

nesses and schools) were effective but they brought about drastic collateral damage. The majority of the world's states are not democracies. Many governments have transposed the contact ban and the suspension of civil rights such as freedom of assembly and the right to demonstrate into laws of unlimited duration, thereby exacerbating authoritarian structures.

In democracies and non-democracies alike, the state-ordered closure of the economy is likely to have driven thousands of people, mainly the self-employed and small businesses, into economic ruin.[23] All pupils had to put up with deficits in comparison to face-to-face teaching due to months of homeschooling. The switch to digital teaching, which did not go well in many households, widened the gap between rich and poor pupils, as the digital infrastructure in the parental homes is often worse for the latter.

In almost every country of the world, supplementary budgets or economic stimulus packages were adopted in the first half of 2020 to cushion the economic slump. As a result, the national debt, in principle a burden shifted from today's to future generations, reached astronomical levels, especially in the USA, where presidential elections were due in November 2020. In the Eurozone, the hard-won debt rules were unceremoniously repealed. In Germany, the grand-coalition government repeatedly suspended the debt brake under Article 115 (2) of the German Constitution (Grundgesetz) in order to put together aid packages.

Before SARS-CoV-2, mankind was already aware of six other coronaviruses. The seventh human-pathogenic coronavirus will certainly not be the last. And it is almost certain that there will be new influenza viruses, including some that will be harmful for us. How can we avoid pandemics in the future without choking off the economy and accumulating a mountain of debt? This is where new vaccination strategies and imperatives come in. Both vaccine preparedness (i.e. the individual) and the availability of good and free vaccines (i.e. policy) play a role in this issue.

7. Vaccination strategies under the aspect of intergenerational justice

7.1 Informed vaccination ethics – some medical facts

Vaccination[24] aims to create immunity in a population in a preventive way (without people going through the disease) in order to bring epidemics to a halt and, ideally, to completely eliminate the diseases in the long term. Eliminated diseases or those that are kept in check do not cause illness, so no economic lockdown is necessary and consequently, no new debt is needed to reduce the economic damage by setting up stimulus packages. Once a virus has been eradicated, which has so far only been possible with the strains of the smallpox virus that are harmful to humans (Variola major and Variola minor), mankind can now save the costs for the corresponding vaccinations. The eradication of vaccine-preventable diseases would be a blessing for future generations – just as the eradication of smallpox by our predecessors is a blessing for us.

The WHO recommends a series of childhood vaccinations (e.g. polio, pneumococcal and hepatitis B). The actual vaccination calendar shows that the majority of the vaccinations are given to children aged around 2 months, i.e. children who do not have any

Tab. 4: WHO vaccination calendar

(updated September 2020)

Table 2: Summary of WHO Position Papers - Recommended Routine Immunizations for Children

Antigen		Age of 1st Dose	Doses in Primary Series	Interval Between Doses			Booster Dose	Considerations (see footnotes for details)
				1st to 2nd	2nd to 3rd	3rd to 4th		
Recommendations for all children								
BCG [1]		As soon as possible after birth	1					Birth dose and HIV; Universal vs selective vaccination; Co-administration; Vaccination of older age groups; Pregnancy
Hepatitis B [2]	**Option 1**	As soon as possible after birth (<24h)	3	4 weeks (min) with DTPCV1	4 weeks (min) with DTPCV2			Premature and low birth weight Co-administration and combination vaccine High risk groups
	Option 2	As soon as possible after birth (<24h)	4	4 weeks (min) with DTPCV1	4 weeks (min) with DTPCV2	4 weeks (min),with DTPCV3		
Polio [3]	**bOPV + IPV**	6 weeks (see footnote for birth dose)	4 (IPV dose to be given with bOPV dose from 14 weeks)	4 weeks (min) with DTPCV2	4 weeks (min) with DTPCV3			bOPV birth dose Transmission and importation risk criteria
	IPV / bOPV Sequential	8 weeks (IPV 1st)	1-2 IPV 2 bOPV	4-8 weeks	4-8 weeks	4-8 weeks		
	IPV	8 weeks	3	4-8 weeks	4-8 weeks		(see footnote)	IPV booster needed for early schedule (i.e. first dose given <8 weeks)
DTP-containing vaccine [4]		6 weeks (min)	3	4 weeks (min) - 8 weeks	4 weeks (min) - 8 weeks		3 Boosters 12-23 months (DTP-containing vaccine); 4-7 years (Td/DT containing vaccine), see footnotes; and 9-15 yrs (Td)	Delayed/ interrupted schedule Combination vaccine; Maternal immunization
***Haemophilus influenzae* type b** [5]	**Option 1**	6 weeks (min) 59 months (max)	3	4 weeks (min) with DTPCV2	4 weeks (min) with DTPCV3		(see footnote)	Single dose if >12 months of age Not recommended for children > 5 yrs Delayed/ interrupted schedule Co-administration and combination vaccine
	Option 2		2-3	8 weeks (min) if only 2 doses 4 weeks (min) if 3 doses	4 weeks (min) if 3 doses		At least 6 months (min) after last dose	
Pneumococcal (Conjugate) [6]	**Option 1 3p+0**	6 weeks (min)	3	4 weeks (min)	4 weeks			Schedule options Vaccine options HIV+ and preterm neonate booster
	Option 2 2p+1	6 weeks (min)	2	8 weeks (min)			9-18 months	
Rotavirus [7]		6 weeks (min) with DTP1	2 or 3 depending on product	4 weeks (min) with DTPCV2	For three dose series – 4 week (min) with DTPCV3			Vaccine Options Not recommended if >24 months old
Measles [8]		9 or 12 months (6 months min, see footnote)	2	4 weeks (min) (see footnote)				Combination vaccine; HIV early vaccination; Pregnancy
Rubella [9]		9 or 12 months with measles containing vaccine	1					Achieve and sustain 80% coverage Co-administration and combination vaccine; Pregnancy
HPV [10]		As soon as possible from 9 years of age (females only)	2	6 months (min 5 months)				Target 9-14 year old girls; Multi-age cohort vaccination; Pregnancy Older age ≥ 15 years 3 doses HIV and immunocompromised

Refer to http://www.who.int/immunization/documents/positionpapers/ for table & position paper updates.

This table summarizes the WHO vaccination recommendations for children.The ages/intervals cited are for the development of country specific schedules and are not for health workers.

National schedules should be based on local epidemiologic, programmatic, resource & policy considerations. While vaccines are universally recommended, some children may have contraindications to particular vaccines.

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Source: https://www.who.int/immunization/policy/Immunization_routine_table1.pdf

decision-making autonomy of their own. This is important, because vaccination ethics too often focuses on autonomous *adults* only.

Without this being a compulsory vaccination scheme in the strict sense, the circumstances are such that most parents have their children vaccinated in (paediatric) medical practices. This enables the WHO to set the targets as ambitious as needed, often aiming for at least 95 percent population immunity. The member states of the WHO have committed themselves to eliminating measles, polio and rubella, among others. While some countries achieve the high WHO vaccination rates, most others fail to do so. For poliomyelitis in particular, something needs to be done urgently: As part of its activities to eradicate poliomyelitis globally, the WHO was able to certify the European Region as polio-free in June 2002. The Member States of the WHO European Region have committed themselves to take measures to monitor the polio-free status achieved in their respective territories and to maintain it until a global eradication of polio is confirmed. To avoid the risk of further spread of an imported poliovirus, a vaccination rate of at least 95% is considered necessary by WHO, otherwise the disease could be reimported. But in the examined birth cohorts from 2008-2017, this rate was around 90% nationwide without any significant variation and is therefore too low to prevent the risk of further spread.

Delayed vaccination, be it against polio or something else, exposes young children to the risk of infection for an unnecessarily long time or, as in the case of HPV vaccination, can lead to the vaccination not reaching its full potential. In the case of rotavirus vaccination, untimely vaccination even carries an increased risk of vaccination complications. However, late or inadequate vaccination also unnecessarily increases the risk of the pathogen spreading and makes it more difficult to achieve national and international public health goals (RKI 2020: 23).

In vaccination ethics, and indeed in the entire public health debate, the principle of "population health maximisation" – which is obviously compatible with the health of future generations as well – is considered a core value (WHO 2008; Kompetenznetz Public Health COVID-19 2020). The morbidity and mortality caused by infectious diseases should be as low as possible. Vaccination strategies should be evaluated according to this principle. One of the main reasons why parents have their children vaccinated is to protect them – and thus indirectly to protect themselves. This is a self-interested motive. For (vaccination) ethicists it is more relevant that vaccinations contribute to the protection of others. According to Giubilini (2019: 1), the "choice whether to vaccinate oneself (…) is by its own nature an ethical choice: it requires individuals to act not only or even not primarily to promote their self-interest but also or even primarily to contribute to an important public good like herd immunity." Getting vaccinated is also a matter of protecting people who cannot be vaccinated, e.g. due to age-related ineffectiveness of vaccines, vaccine intolerances due to illness or immunosuppression (e.g. during chemotherapy). "For example, the measles, mumps and rubella (MMR) vaccine is also used to vaccinate against rubella, which is intended to protect the unborn child, not the person being vaccinated" (Schröder-Bäck/ Martakis 2019: 472).

But it should be noted that a vaccination is always a challenge for one's own immune system and an itchy prick, a headache or a one-day mild fever is an expected reaction. In fact, these reactions of the body are desired because they show that the immune system is boosted. In that sense, it is impossible by principle that vaccines are "absolutely safe" (as is sometimes demanded by journalists or the public).[25] What one does not want to see are life-threatening effects directly after the jab (such as anaphylatic shocks) or unusual effects in the weeks or months after. The following case study gives an example of an unexpected side effect.

Case study: AstraZeneca and the blood clots

COVID-19 Vaccine AZD1222 is a vector vaccine developed by the University of Oxford and the British-Swedish company AstraZeneca. It is made up of a virus of the adenovirus family that has been modified to contain the gene for making a protein from SARS-CoV-2. By mid-March 2021, more than 7 mio. doses in the EU (11 mio. in the UK) had been administered. On 15 March 2021, the majority of EU countries, including France and Germany, temporarily paused vaccination when a total of 18 cases of a rare blood clot in brain vessels were counted in several EU countries. Vaccination resumed after EMA issued a statement three days later that

- the benefits of the vaccine in combating the still widespread threat of COVID-19 (which itself results in clotting problems and may be fatal) continue to outweigh the risk of side effects;
- however, the vaccine may be associated with very rare cases of blood clots associated with thrombocytopenia, i.e. low levels of blood platelets (elements in the blood that help it to clot) with or without bleeding, including rare cases of clots in the vessels draining blood from the brain.

Blood clots in the brain are certainly an unwanted side effect. For the ethical analysis, let us assume that there would be a causal link (and not just a correlation) between the AstraZeneca jabs and these blood clots, then the risk would be 1:1.000.000 (as 18 such effects happened when 18 million people were vaccinated in the EU and the UK). If 160.000 people were not vaccinated against Covid-19 between mid-March and end-March 2021, statistically between 750 and 1,500 would die.[26] Those blood clots were not rare, they were not very rare, they were super-rare. Apart from that, some people, e.g. young women, are more exposed to the risk of blood clots than others. The personal benefit-cost analysis would thus have to weigh my risk of such a thromboembolic event against the risk of getting the disease COVID-19, with its associated risk of hospitalisation and death. All reactions of the immune systems to the jab ("side effects") – wanted and unwanted – are to a certain extent different for each human organism and therefore there is always a *personal* risk-benefit balance.

7.2 Vaccination ethics with regard to children

As mentioned, most vaccination decisions (unlike in the case study above) relate to children.

With regard to children, the argument of parental will is added, i.e. the right to make the final decision on whether one's own children will or will not be vaccinated. But this parental right is a "serving right" – it must serve the welfare of the child. This is generally the case with vaccinations because they are especially beneficial for children. With regard to many viruses, children's immune systems have no experience with them and therefore no (partial) immunity, which could lead to easier disease progression. That childhood vaccinations serve to protect children is perhaps best illustrated by the example of smallpox, which for centuries

killed and disfigured children (more than any other age group).
It is therefore possible to draw the interim conclusion that there is a moral parental obligation to have one's children vaccinated.[27] Since child welfare in particular and herd immunity in general are important public goods, ethical questions arise also at the level of state action with regard to the obligations to implement vaccination policies, if necessary coercive ones (Giubilini 2019: 1). This leads on to the controversially discussed state duty to vaccinate children. It goes beyond a strategy limited to appeals, but must also be distinguished from compulsory vaccination (see the scale of the *Nuffield Council on Bioethics*, with which the intensity of state vaccination strategies can be depicted).[28] The step from the postulation of a moral duty to the positivisation of this duty in a legislative or regulatory text seems logical. Fines for parents who neglect their moral duties towards their children are sensible consequences. Moreover, unvaccinated children cannot be admitted to schools or to day care centres for reasons of third-party protection.[29]

7.3 Arguments by vaccination deniers

As an argument against vaccination, vaccination opponents cite the naturalness of fatal diseases (Gamlund et al. 2020). However, this argument is based on a Darwinian world view and seems generally untenable for ethical reasons. Another argument is a general distrust in the health care system (European Commission 2018). It is difficult to argue against this because a deep-seated mistrust cannot be removed by arguments. While some mistrust arguments against vaccination do deserve ethical consideration, others do not as they are just "false facts". The WHO Guide Best *practice guidance. How to respond to vocal vaccine deniers in public* mentions for instance the "argument" that diseases preventable by vaccines are either eradicated or have proven harmless.[30]
The rich countries of the Global North, whose inhabitants suffer from infectious diseases much less frequently than inhabitants of the Global South, are usually much more suspicious of vaccines than the inhabitants of poorer countries. Due to the already mentioned fact that infectious diseases no longer play a major role in the life planning of people in the West, vaccines have also become "a victim of their own success" (IVaccinate 2019).
Then there is the judgement of vaccination opponents that they themselves (or their own children) could belong to the 5 % unvaccinated (because a herd immunity of 95 % instead of 100 % is sufficient). This behaviour is simply "free-riding" (cf. Marckmann 2008: 213; Kompetenznetz Public Health 2020: 4). This mentality is an egoistic lack of solidarity.
The introduction of further compulsory childhood vaccination measures should be accompanied by a strengthening of low-threshold measures (lower levels of the Nuffield scale). All vaccinations from the WHO vaccination calendar must be free of charge and easily accessible. This includes compulsory information sessions[31] at various levels (family doctor, school, association, etc.) as well as the creation of the necessary capacities for this. Creative educational measures should be developed so that the population can understand the benefit of their herd immunity for future generations. Through telephone calls and letters, the authorities could ensure that parents do not miss their children's refresher appointments.[32] However, the effects of appeals are always limited (lack of time by parents, procrastination, etc.), and an increase in vaccination rates would be uncertain. By contrast, almost all studies that compared vaccination rates in different countries before and after the introduction of compulsory vaccination have shown a clear increase in participation.[33] In France, parliament has increased the number of compulsory vaccinations from three to 11 in 2017. The immunisation rate for children born in 2018 has increased accordingly (Bruhl et al. 2019: 1). To enable studies and scientific research it is urgently necessary for all countries to keep an electronic vaccination register to identify the vaccinations carried out.
If an infectious disease is not eradicated worldwide, then it is not eradicated. In the words of WHO Director Tedros Ghebreyesus: „No one is safe until everyone is safe."[34] Therefore, young children all over the world (including the developed countries) should be vaccinated against tuberculosis. Around 2 million people die of this disease worldwide every year – no infectious disease claims more victims. The pathogens are becoming increasingly resistant to the antibiotics used so that in an interconnected world each country must contribute to ensuring that as many people as possible gain immunity. In this context, the medical phenomenon of "silent release" is particularly interesting. In immunology, this is understood to mean that a (human) organism becomes completely immune to the pathogens of an infectious disease after vaccination or infection, as is the case with the oral tuberculosis vaccine. There are also indications that live vaccines against tuberculosis, but also against polio and measles, provide a non-specific antiviral effect against SARS-CoV-2 (Chumakov et al. 2020; Benn et al. 2013; Cumakov et al. 1992). In other words: Those who were vaccinated with live vaccines as children have a lower risk of contracting COVID-19 today.

7.4 Further vaccination ethical arguments

Might these considerations also lead to an obligation to vaccinate adults? This is where the argument of autonomy comes in. "Various preventive measures, such as compulsory seat belts for drivers or smoking bans in public buildings, restrict the freedom of action of citizens under state sanctions. Are these interventions in the autonomy of the individual ethically justifiable?" asks Marckmann (2008: 2010). Well, general considerations of negative freedom (rights of defence against the state) speak against state sanctions for vaccination refusers who have reached the age of majority. Adults should not be vaccinated forcibly against their declared will.[35] However, the opponents of mandatory vaccination for *adults*, for instance against SARS-CoV-2, often rely on dubious arguments. Their argument is that people want to decide for themselves which risks they want to protect themselves against and how. In our liberal society, it should remain permissible to endanger oneself. Anyone who likes off-piste skiing or other high-risk sports should not be prevented from doing so by others. In the context of epidemics, however, it is also a question of external danger. The argument of one's own unrestricted freedom must take a back seat to the need to protect others – a prerequisite for others to be able to live freely. To stay in the picture: If a ski mountaineer constantly triggers avalanches that endanger other people, then one may (and should) prevent him from doing so. If a vaccination opponent voluntarily stays away from all fellow human beings, his refusal to be vaccinated can still be justified by reference to his autonomy, but as soon as this unvaccinated person makes contact with others, he accepts their harm. While children cannot become permanently self-isolated in everyday life (they

must go to school, as not going would lead to serious damage as a result), this self-selected self-isolation does not seem completely impossible for adults. But the community can take measures to ensure that unvaccinated people really do not endanger the health of others: a lockdown for vaccination refusers is justified if vaccines are readily available.

Ultimately, the question of the right vaccination strategy can only be discussed in context, i.e. in relation to a specific infectious disease or its pathogen. For instance, vaccines against influenza do not have any dangerous rare side effects, not even with a probability of 1: 1 million. And many experts assume that the next major pandemic will be an influenza pandemic (Schlag/Wenz 2020). "No vaccination can save more lives in this country," said the Robert Koch Institute after the flu pandemic in Germany in 2017/18.[36] The vaccination rate for over sixty year olds was just 34.8% in 2017/2018.[37] The risk of dying of influenza is many times higher in this age group than the risk of dying in road traffic. Careless handling of influenza viruses should be a thing of the past after the current corona pandemic. However, the effectiveness of the influenza vaccines developed varies greatly from season to season because the pathogen mutates.[38] But the latter means nothing other than that the extremely dangerous influenza variant H1N1 (which was responsible for both the Spanish flu of 1918-19 and the swine flu of 2009) mentioned above can occur again at any time. Each of the new influenza vaccines that are launched each year have cross-protection (i.e. protection against virus types that are not included in the vaccine). It should not be forgotten that both influenza and coronaviruses affect the airways. Those who were vaccinated against the flu in autumn 2019 could feel safer in spring 2020 than if they had not been vaccinated against it. They could then get COVID-19, but not an additional respiratory infection. These interactions are also important for the future waves of the corona pandemic. A team of 37 scientists, led by Stephan Holgate, modelled the "second wave" for Great Britain in early July 2020 and determined that the maximum possible number of 120,000 additional deaths could be significantly reduced if there were more flu vaccinations (Mills 2020). The British Minister of Health, Matt Hancock, announced that the "largest flu vaccination programme in history" would be in place in winter 2020/2021. British opposition leader Keir Starmer has already called for free vaccinations for all over-50s in pharmacies to avoid a "perfect storm" (seasonal wave of flu with a pathogen of unknown aggressiveness and second wave of SARS-CoV-2) in autumn (Lintern 2020).[39]

If the current pandemic had been triggered by an influenza family virus instead of a corona family virus, we would have had a debate long ago on the extent to which we could create more background immunity in the future by increasing vaccination coverage, thus avoiding high rates of infection or death (and consequently a lock-down of companies and schools). For too long, the fight against influenza viruses has only been an issue for special working groups, which have received little attention from politicians and the media. The Spanish flu of 1918-19, the Asian flu of 1957-58, the Hong Kong flu of 1968 and the various avian and swine flu epidemics, mostly named after their host species, should prompt us to treat the annual flu vaccination differently than we have done in the past. The population should be informed every autumn on posters, radio and TV spots as soon as flu vaccination is possible in September. This vaccination should be available free of charge in pharmacies, which should significantly increase the willingness to be vaccinated. All successful vaccination campaigns in the history of medicine show: Vaccinations must come to people, not people to vaccinations. Shifting flu vaccinations to pharmacies or vaccination centres, in addition to doctors' offices, would make a significant contribution to increasing the flu immunity in the population to a sufficient level. While it is legal in many EU countries, the UK and the USA that pharmacists give jabs, Germany this has only been possible in a few pilot trials so far.[40] In Switzerland, people have been able to get vaccinated against influenza in pharmacies for five years now – the vaccination rate has risen by 15% as a result (Eger 2020). A high vaccination coverage rate throughout the population (especially the younger generation) can provide collective protection against influenza for the elderly, whose immune systems are weaker than those of younger people.

7.5 Being able to get vaccinated – prophylactic vaccine research and stockpiling

This leads to the demands on politicians – for a vaccination policy. Humanity has done too little to prevent epidemics, which is why we were very ill-prepared for "the next big one" among the pathogens, namely SARS-CoV-2 (Gates 2018). SARS-CoV-2 is – like SARS-CoV-1 and MERS – a beta coronavirus. Both SARS viruses belong to the same line and are therefore genetically very closely related. When SARS-CoV-1 broke out in Asia in 2002, some good vaccine candidates were developed, but hardly any of them made it into clinical trials (i.e. tests with human subjects) before the disease was contained by public health measures. After that, funding ceased and further research was no longer worthwhile for companies and universities. The fact that research on a vaccine against the SARS-CoV-1 virus was abandoned too early took its toll during the SARS-CoV-2 pandemic.[41] But we should be aware that the development of a vaccine costs a high triple-digit million amount, often one to two billion euros.

The history of vaccine development for Ebola is another case of premature interruption. Ebola was feared for a time by the Americans as a biological warfare agent, so a lot of money went into research and development of a vaccine. The genome of the pathogen has been sequenced at a rapid pace. But in the end, the outbreaks were limited to a few poor African states, with the result that the rich countries stopped funding too early (Berkley 2020; Hanrieder 2015). Thus, from 2014 to 2016 Ebola could ravage in West Africa and infect 28,600 people, of whom 11,300 died.[42] Even for influenza vaccines, for which there is actually an excellent production infrastructure, production capacity would be insufficient in the event of a dangerous variant. In the case of the H1N1 Influenza 2009 (swine flu), vaccine manufacturers quickly switched their production lines to produce a new vaccine to protect against a single pathogen (monovalent vaccine) instead of the seasonal vaccine. Nevertheless, the vaccine was not launched until six months later – much too late (Kekulé 2009).

7.6 Collateral benefits of the corona pandemic

The SARS-CoV-2 pandemic has led to an unprecedented effort by the global community to develop and distribute a vaccine against this virus in 2020. It led to a breakthrough of the mRNA technology – this is an important collateral benefit for vaccine research in general. These novel vaccines no longer contain at-

tenuated whole viruses, but instead, for example, the "blueprint" for a viral protein in the form of a messenger ribonucleic acid (messenger RNA or mRNA for short).[43] Some experts believe that even a universal vaccine against influenza is not an unattainable goal (Schlag/Wenz 2020), if more support were given to research into influenza vaccines in general.

The course of the development of vaccines against SARS-CoV-2 also showed that regulatory procedures could be accelerated by so-called rolling reviews, without compromising safety in an unduly way. Normally, all data on a medicine's effectiveness, safety and quality and all required documents must be submitted at the start of the evaluation in a formal application for marketing authorisation. In the case of a rolling review, regulatory bodies like the European Medicines Agency (EMA), the U.S. Food and Drug Administration (FDA) or the Medicines and Healthcare products Regulatory Agency (MHRA) of the UK review data as they become available from ongoing studies before a formal application is submitted. Once the agencies decide that sufficient data are available, the formal application can be submitted by the pharmaceutical company. By reviewing the data as soon as they become available, the regulatory agencies can reach their opinion sooner on whether or not the medicine or vaccine should be authorised. This application of the "just-in-time" processing of data shows that approval procedures lasting years (or even decades) are not (or were not) inevitably necessary to ensure adequate vaccine safety.

7.7 The global dimension

Before the corona pandemic, the following applied: "Global disease control suffers from a notorious shortage of resources, especially in view of weak health systems in developing countries, and is characterised by distribution conflicts between poor and rich countries" (Hanrieder 2015). In the face of the current global corona pandemic – and the prospect of more zoonoses in the future – we should recognise: The prevention strategy has a territorial dimension that goes beyond the national framework. We know with certainty that the next outbreak will come, we just do not know when and where. We must think globally today if we want to prevent local outbreaks (epidemics) from becoming global (pandemics) in the future (Harari 2020b/Harari 2020c). Vaccine production factories must be distributed worldwide. After all, if a laboratory in Oxford or Tübingen has produced a vaccine, it is not yet "in people". The latter can only happen quickly – and speed is of the utmost importance – if the vaccine can be produced in large quantities on all continents. This, however, may sound like a bigger challenge than it actually is. Till Koch, a physician and infection researcher, explains: "It makes sense to research exactly those viruses that also have the potential to spread globally in a pandemic. There are not many types of viruses that are capable of doing this. To spread globally so quickly, a virus must be able to trigger a respiratory disease. And there are not that many. Coronaviruses are some of them, influenza viruses and para-influenza viruses and certainly a few others – but it is not true that all families of viruses have the potential for a pandemic". As stated above, it is very likely that new pathogens will be created by zoonoses. Koch continues: "One would have to specifically examine animals for viruses, characterise these viruses and find those that are on the verge of spreading to humans. Vaccine candidates could then be developed against precisely these types of viruses, and tested for safety and tolerability in preclinical and phase 1 studies. It is then rather unlikely that these viruses will trigger the pandemic. But there is a high chance that the viruses that will actually trigger the pandemic are relatively close to those that have already been tested. In that case, only a few sequences might have to be exchanged, and one could then start the clinical trial right at the top. Moreover, it is quite possible that cross-protection exists, i.e. that an already existing stockpile of vaccine candidates can be used to contain an outbreak as early as possible" (Koch 2020).

The international community has the resources to a) eradicate those pathogens that are genetically stable and only occur in humans; and b) to locally limit outbreaks of all the others. But the international community needs the will to do so. The challenge for policy-makers is therefore to ensure that the capacity is created to develop and produce a vaccine in a few months *before* the next really dangerous pathogen breaks out. According to all experts, this is possible if budgets, and especially the WHO budget, are significantly increased. Today, we all are in the same boat, given the degree of our global connectedness. A pathogen does not care whether its prey has a light or dark skin colour.[44] Vaccines should therefore not only be defined as "public good" within Western countries (see above) but as "global public good". Through a global fund administered by the WHO, humanity should ensure that future generations are plagued by fewer scourges than humanity is today. In the case of global public goods, basic funding is provided by states. To immunise the entire world population against the most serious infectious diseases, it would take a total of tens of billions of dollars, as Seth Barkley, head of GAVI (an alliance for vaccines), points out (Berkley 2020). This is a fraction of the billions of dollars in losses the global economy is currently suffering.

There are some signs, luckily, that mankind has recognised the signs of the times. The record amounts of money that governments have pledged for vaccines at donor conferences during the corona pandemic show the beginning of a paradigm shift. Some years ago (2016), with the Global Virome Project, humanity recognised the need to identify the viruses (families) that could be extremely dangerous for humanity.[45] This project aims to determine the genetic codes of the viruses discovered and published them so that researchers can identify viruses and combinations of genes in viruses that are particularly relevant to humanity. A specific objective of the programme is to identify the genetic similarities of dangerous viruses. This has immediate benefits, as shown by the example of SARS-CoV-1 and SARS-CoV-2. What is new since 2020 is that state funding alliances are finally providing the funds to proactively develop vaccines. Before the corona pandemic, payments had fallen short of commitments. CEPI, an initiative of the World Economic Forum in Davos, had received only 5 % of the funds needed until the start of the corona pandemic (BBC 2020). Because the prophylactic development of vaccines is a loss-making business for companies (World Health Organization 2020b), significantly higher sums of state and private money for vaccines will be needed in the long term. In addition to prophylactic vaccine research ("approval sleeves") and improved approval procedures, the stockpiling of vaccines also plays an important role in prevention in the sense defined above. In any case, it is cheaper to destroy unnecessarily acquired vaccine reserves if they cannot be used by the expiry date than to subject the economy to a lockdown.

The first doses of reliable and health authority certified vaccines against SARS-CoV-2 were delivered in the EU at the turn of the years 2020/21. Once the vaccination campaign is working properly, our lives will return to normal. The danger is that once the current pandemic is over, the West may once again leave the rest of the world alone, instead of seeing the fight against infectious diseases – first SARS-CoV-2, then other ones – as a task for our generation as a whole, as our service to future generations. During a pandemic, states and companies commit themselves to do everything necessary to "defeat" the pathogen. But once the pandemic is over and the dead are buried, the survivors forget these promises. An important lesson from the smallpox eradication campaign is that really long breath is needed and that it is important to track even the last case of smallpox (in the case of smallpox, this was the Somali cook Ali Maow Maalin).

8. Conclusion

There are about known 1,500 pathogens that can make people ill. Many of them are genetically stable. Mankind could completely eradicate some of them, as we have done in the past with the smallpox virus. And it could establish immunity against other diseases through vaccination and thereby eliminate them. Terrible scourges of humanity like polio, measles, malaria, dracontiasis or typhoid could disappear from our planet. And we can ensure that infectious diseases do not become global pandemics on the scale of the lung disease COVID-19.

In the 20th century, mankind succeeded in eradicating smallpox in a targeted manner. What is our generation doing today, in the 21st century? If we want to eradicate the above mentioned diseases,[46] we must radically change our consciousness. Books about the milestones in the history of vaccination will then belong in every household,[47] and the epidemic policy goal of humanity will be part of every school curriculum. Not only our governments, every one of us can make an important contribution to this global human task.

Vaccination does not come without risks, but it is the only sustainable way to permanently remove many highly infectious pathogens from the list of problems that future generations will have to deal with. We, all people worldwide, should remember and celebrate December 9th every year. On this day in 1979, WHO experts had unanimously declared that smallpox had been eradicated.[48] If we all realize the significance of this day, if every child knows it by heart, then we will be in the right frame of mind to protect future generations from terrible epidemics.

The corona pandemic has been a wake-up call. If we look back from 2100 to 2020, our present time could be seen as the time in which humanity mentally got ready to eradicate some of the most deadly infectious diseases worldwide, following the successful model of the eradication of smallpox.

Notes

1 Here understood as intertemporal generational justice (justice between present and future generations), not as justice between young and old within the group of those living today.

2 According to Werner/von Lengerke (2003: 311), health policy is "intergenerationally just" if the chances of all succeeding generations to satisfy their own health needs are at least as great as those of the generations that preceded them.

3 Often the pathogens that are dangerous for humans are also dangerous for our closest relatives in the animal kingdom. The Ebola virus probably killed more gorillas than humans (Quammen 2013: ch. 21).

4 Except for some small residual stocks in high security laboratories.

5 For more details see Witte 2008; Spinney 2018; Lange 2020.

6 https://www.euro.who.int/en/health-topics/communicable-diseases/influenza/seasonal-influenza/burden-of-influenza.

7 Since the influenza virus of the so-called swine flu is the same subtype, A(H1N1), as the devastating Spanish flu, the disease authorities at the time understandably reacted with great concern.

8 The virus family of human-pathogenic coronaviruses comprises two subgroups: Alpha-Coronaviruses and Beta-Coronaviruses. Including SARS-CoV-2, there are a total of seven coronaviruses that have so far become established in humans. Four of them cause mild infections of the upper respiratory tract, which are usually mild and do not cause any problems. The remaining three coronaviruses, SARS Cov-1, MERS and SARS Cov-2, are significantly more harmful to humans (Ziebuhr 2016; Koch 2020).

9 Pathogens can be classified according to their "dangerousness" on the basis of various variables. The DOTS formula models the risk of a disease outbreak on the basis of four variables (time of infection, pathogen contact, number of social contacts, existing herd immunity), see Kucharski 2020. In a meta-study by Levin et al (2020), the infectious mortality of SARS-CoV-2 is given as just under 1%. This makes SARS-CoV-2 one of the very dangerous viruses. In a model study, a team of researchers from the UK calculated that people in Italy who died from COVID-19 had lost more than a decade of life years on average (Hanlon et al. 2020).

10 For many Asian countries, SARS 2002 was already the first disease of the 21st century to "shake the world" (World Health Organization 2006: VII). This is probably one reason why Taiwan, Singapore or South Korea reacted so successfully to SARS-CoV-2. "We have been preparing intensively for this since 2003," says Audrey Tang, Taiwan's Minister of Digital Affairs (Tang 2019). The West has had to learn some lessons, such as that wearing masks in public is an important contribution to disease control.

11 This is what the term "lockdown" has come to stand for. It should not be overlooked, however, that even in the EU, lockdowns differ considerably from country to country. Curfews are a much more drastic measure than contact restrictions, to name just one example.

12 The philosopher Philipp Hübl (2020) refers to this as bullshit resistance.

13 Even in 2020/2021 this thinking has not been eliminated, and unfortunately there are still too many conspiracy theorists for whom either Bill Gates, Angela Merkel, Donald Trump or the Chinese government deliberately brought the virus into the world.

14 A telling example of the view that a pandemic is god-sent is the sermon of the Jesuit priest Paneloux in The Plague by Albert Camus. In some African societies and in India, smallpox even had the honor of its own smallpox deities (cf. Tucker 2002). According to the believers, these gods and goddesses made the decision as to who was ill and who was not. During the worldwide vaccination campaign to eradicate smallpox, this became a cultural problem, as believers feared the wrath of these deities if they were vaccinated.

15 An estimate of how costly various individual disease control

measures are can be found in Thomas Pueyo's (2020b: chart 16) highly regarded article.

16 Jenner had several children, including his own son, undergo the procedure (Williams 2010: 190). His approach would no longer be compatible with current medical ethical standards.

17 The statutory smallpox vaccination had to be enforced often against the resistance of the church (in 1824, Pope Leo XII even banned the vaccination).

18 Zoonoses can be further subdivided into infectious diseases transmitted from animals to humans (zooanthroponoses), those transmitted from humans to animals (anthropozoonoses) and those that can be both (amphiexenoses).

19 In biology and medicine in general, a disease vector (from the Latin word for 'traveler') is a carrier of pathogens that cause infectious diseases without becoming ill itself.

20 In January, the Chinese authorities provisionally banned all wildlife markets.

21 Self-testing at home for the SARS-CoV-2 virus became available during winter 2020/2021 and provided a cheap and easily accessible way for everyone to find out whether one carried the virus. Immediately, a debate started if people are moral enough to behave responsibly towards others if their tests were positive.

22 It should be considered whether the state – i.e. the community of all citizens – should pay state compensation to its quarantined fellow citizens, regardless of actual loss of earnings. However, this cannot and must not be a prerequisite for (self-)quarantine.

23 In democracies, curfews and contact bans were interventions that many people would have considered unthinkable before the outbreak of this pandemic.

24 The following refers to vaccines authorised by health authorities. By definition, all these vaccines have gone through a complex, multi-stage approval process.

25 It is a big problem that one mantra of journalists is that “we cannot communicate probabilities to the public, it is too complicated”. This leads to a press coverage in which 1:1000 and 1:1000000 side effects are equally labelled as “rare cases”.

26 Calculation by the former head of the World Medical Association, Frank U. Montgomery, in the talk show Maybritt Illner on 18 March 2021.

27 It varies from pathogen to pathogen which groups have a particular risk of disease. With SARS-CoV-2, older people are at risk of serious illness and death, while younger people usually have only mild symptoms or no symptoms at all (Begley 2020; Davis et al 2020). In the case of the Spanish flu it was exactly the opposite: at that time it was mainly younger people who died because the bodies of older people had already become acquainted with earlier flu viruses and as a result some antibodies had formed which also offered partial protection (background immunity) against the very aggressive influenza virus of 1918. From the viewpoint of vaccination ethics, those age groups with the highest risk should be vaccinated before those age groups with a lower risk if the vaccine is scarce.

28 Here is the (slightly modified list) of the Nuffield Council on Bioethics (2007):

1. do not actively offer vaccinations, but only on demand, and do not finance them publicly.
2. provide general information about vaccinations and finance recommended vaccinations through the statutory health insurance funds
3. compulsory vaccination advice for doctors or the public health service
4. "kick-starting", by carrying out recommended vaccinations as standard during the doctor's visit (with "opt out")
5. providing incentives for vaccinations (e.g. discounts on the cost of day-care facilities, awarding vouchers for benefits in kind).
6. implement deterrent measures (e.g. contribution to treatment costs for diseases for which one could have been vaccinated).
7. limit options for action, e.g. by making certain treatments or access to public facilities only available to those who are vaccinated (e.g. no access to childcare or school).
8. compulsory vaccination, with physical violence if necessary.

29 This was also confirmed by the German Federal Constitutional Court when, on 1 May 2020, it rejected emergency applications against the Measles Protection Act: "Vaccination against measles in certain community centres should not only protect the individual against the disease, but at the same time prevent the further spread of the disease in the population, if the measures are such that the vaccination rate in the population is high enough. This would also make it possible to protect people who, for medical reasons, cannot be vaccinated themselves but who are at risk of serious clinical consequences if they become infected. The aim of the Measles Protection Act is to protect life and physical integrity, which the state is obliged to do in principle also by virtue of its fundamental duty to protect under Article 2 (2) sentence 1 of the Basic Law". (Federal Constitutional Court 2020).

30 https://www.euro.who.int/__data/assets/pdf_file/0005/315761/Vocal-vaccine-deniers-guidance-document.pdf

31 The smallpox eradication was meanwhile threatened not by the quality of the vaccine, but by a lack of education and courage. Jenner's procedure, infecting a healthy person with a substance from a sick cow, was immediately rejected by some contemporaries as illogical, unnatural and repugnant (Tucker 2002). To this day these immediate impulses against vaccination still exist.

32 “The reasons why people choose not to vaccinate are complex; a vaccines advisory group to WHO identified complacency, inconvenience in accessing vaccines, and lack of confidence are key reasons underlying hesitancy.” (World Health Organization 2019b).

33 This is the conclusion of a literature report of 11 before and after studies (Lee / Robinson 2016). Rezza (2019: 293) notes an increase of the vaccination rate in Italy by 4.4% since the introduction of compulsory vaccination in 2017.

34 https://www.euronews.com/2020/08/18/coronavirus-19-european-countries-record-high-incidence-rates-as-surge-continues

35 The term refers to a violation of physical integrity, i.e. the physical administration of the vaccine against the declared will of the vaccinated person.

36 https://www.rki.de/DE/Content/Service/Presse/Pressemitteilungen/2018/09_2018.html

37 https://www.rki.de/DE/Content/Service/Presse/Pressemitteilungen/2018/09_2018.html

38 Unlike smallpox or measles, for example, which are genetically very stable viruses.

39 In the winter of 2019/2020, around 8,000 Britons died of influenza.

40 German pharmacists had offered to provide COVID-19 vaccinations at their annual meeting on 21 September 2021. But the doctors' guild, which competes with them, immediately spoke out against it.

41 Frank Snowden, author of a major work about pandemics in history (2019), says: "Our problem is that we do not promote science in the right place, that we do not use it wisely. We could have had a coronavirus vaccination long ago. But after SARS disappeared and MERS proved to be less easily transmissible, the development was no longer worthwhile. In the end, the pharmaceutical industry is all about profit" (Hackenbrock 2020: 106).
42 Epidemiologist Kekulé draws three conclusions:
(a) Disease prevention must become an integral part of development aid, (b) we need an early warning system for new pathogens, and (c) a medical response unit must be able to be deployed quickly to control epidemics in a crisis (Kekulé 2015).
43 For a constantly updated status of vaccine research against SARS-CoV-2, please consult https://covidvax.org/; see also the WHO overview of all approved vaccines and all vaccine candidates https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines.
44 However, sometimes genetic differences between people mean that a virus can cope better with one human host than with others, and that there are different courses of disease. People with blood group A positive are more at risk for a severe COVID-19 progression.
45 So far, 111 viral families have been identified. 25 of them are suspected of being able to infect humans. Within these 25 families, there are about 1.67 million hitherto unknown viruses in mammals or birds; both species account for 99 percent of virus hosts. Of the 1.67 million viruses, between 613,000 and 827,000 are human pathogenic, i.e. can jump to humans and potentially damage them (Comforter 2020: W7).
46 The vaccination trick how the CIA managed to chase down al Qaeda leader Bin-Laden was a major coup in the U.S.-led war on terrorism, but it also was also a setback the war on polio (McGirk 2015).
47 On the history of the eradication of smallpox, see Henderson 2013; Williams 2010; Koplow 2003; Hopkins 2002; Tucker 2002; Fenner et al 1988.
48 On 8 May of the following year, the 33rd World Health Assembly ratified an official multilingual document that declared smallpox eradicated.

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