

**A proactive approach
to fight SARS-CoV-2 in Germany and Europe**

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Summary

This paper develops a sustainable way to deal with the Covid-19 pandemic. The strategy presented here aims to avoid new infections, deaths and more nationwide lockdowns. It consists of three core elements: First, a rapid reduction in the number of infections to zero. Second, the avoidance of transmissions/reintroduction of the virus into virus-free green zones through local travel restrictions, tests and quarantines. Third, rigorous outbreak management if new cases occur sporadically.

In June/July of last year, Germany and many other European countries reached a situation of low incidence after a major struggle but failed to maintain it in the long run. In order to succeed this time, our countries need a concrete and uniform overall goal as well as a consistent strategy for reopening and the time thereafter. The NO-COVID target and the Green Zone strategy, for which we advocate, have already been applied successfully in several countries, thereby enabling their populations to return to a nearly normal life situation. For the Federal Republic of Germany and other European countries this path is both possible and optimal.

The new virus variants pose a huge challenge for all of us

As we had to learn painfully, SARS-CoV-2 cannot be tackled using a containment strategy through non-pharmacological interventions. The reason is its unfavorable ratio of infection-, disease- and death rates. The pandemic situation has now gotten worse due to the new virus variants. These new variants will be the dominant variants within a few weeks given all projections for the current infection process (R value around 1). For the B.1.1.7. variant, it is epidemiologically proven that it is more infectious than previous variants, which makes fighting the pandemic much more difficult and could force the healthcare system into a new overloaded situation within a very short time. In order to delay or prevent the spread of the new variants, we have to reduce the number of cases immediately to the lowest possible values by acting quickly and decisively.

Focused protection of vulnerable groups is neither feasible nor justifiable

It has proven difficult to protect the elderly population from the virus. In spite of great efforts, current incidences show the virus was introduced into the elderly population and registered in elderly care facilities. There are also many citizens with underlying health conditions who have a high risk of severe disease. Overall, the vulnerable population is estimated at about 40% of the total population. Hence, it seems completely unrealistic to let the pandemic run freely and to be able to protect vulnerable groups at significantly higher rates of incidence. In addition, the uncontrolled spread of the pandemic will rapidly fill hospitals with young patients and lead to high death rates of several 10,000s in the under 65 years old age group. Furthermore, the now known long-term consequences of COVID-19 will cause persistent damage to health even with

mild courses of the disease in the under-65s. Letting the pandemic loose is therefore not an option.

We know: every infection is one too many

The SARS-CoV-2 virus will continue to cause great harm to society in the coming months, in which the vaccination of the population will not be advanced enough and no significant therapies against COVID-19 will be available. This is even more relevant in view of the much more infectious new variants of the virus. So we have to move away from reactive harm reduction and towards proactive control of the pandemic, comprising all social, health and economic areas of our society, with a clear goal that enables a return to freedom and stability: NO-COVID.

We learn from other countries that consequent elimination as a strategic goal leads to the least harm to society

The current situation is an ordeal for society. The proposal presented here creates a new narrative that aims to include the population and take everyone on board: It is important to defeat the virus together. Other countries have been successful because of clear objectives and a collective social effort. After the first wave, we achieved an incidence of 2.5 / 100,000 per week in Germany. So, it is possible. NO-COVID leads us out of the cycles of (re)introduction and repeal of prohibitions and restrictions on fundamental rights. The NO-COVID strategy motivates the population through a common goal and shows citizens a perspective to end this "walking on eggshells" situation permanently. It conveys that we are members of a community who can do something to return to a normal life, but also that you can rely on government measures and aid.

Regional focus of measures through Green Zones

The NO-COVID strategy formulates a motivational goal for the population, economy and institutions, which will reward their efforts. Through such community efforts, other countries have managed to bring incidences to zero. Where this worked, areas are declared Green Zones and can return to normal. Such a strategy involves strict contact and travel restrictions outside the Green Zone and is supported by strict quarantine rules, as well as an efficient testing strategy and vaccination campaign. The effectiveness of the implementation is constantly monitored and the results are communicated daily with the general population.

Our common GOAL: Achieve and sustain NO-COVID

The goal for everyone is to remain a Green Zone and to gradually expand this Green Zone over Germany and Europe. All measures must be coherent, communicated clearly and should be seen as progressive and flanking to the vaccination of the population. We have to have the goal of NO-COVID clearly in mind and establish a social consensus that we, as a society, do not want to live with the virus. Instead we want to defeat it, in every community, in all of Germany, across Europe and worldwide. This approach requires the support of the entire population and of all of society's actors. Therefore, a Germany-wide communication and motivation campaign is needed to convey the new objective.

The advantages of the NO-COVID strategy

Instead of reacting to the development of the pandemic, we act proactively. This reduces uncertainties and the associated psychological and economic pressure on families. The NO-COVID strategy creates for all areas of society, such as families, schools and businesses the urgently needed safe way to function. This NO-COVID approach is legitimized by a new narrative: not "health" or bed occupancy is the sole focus of efforts, rather the wellbeing of the entire society and the restoration of civil liberties. There are clearly defined goals and criteria. The population becomes part of the common objective and one important actor in achieving goals (bottom up, not top down). This way the fight against the pandemic is in the hands of the entire population as a collective task. Furthermore, the duration of the lockdown is not scheduled to a specific date, which appears arbitrary and leads to frustrating extensions, but it ends with the achievement of the goals, so possibly earlier than estimated if the region acts successfully.

Central elements of the NO-COVID strategy

1. Green zone model: Lockdown to the incidence of 10, then further reduction to Zero.

The lockdown in spring would have been sufficient for this. The city of Melbourne (4 million people) took around 3-4 weeks to reduce it from 10 to Zero. In Germany we had already reached an incidence of 2.5 in summer.

2. Implementation: Leading experts from Australia and New Zealand are ready to offer advice to our interdisciplinary team of scientists and doctors and of course German politics. The pioneer of the Green Zone model also supports our scientists with his experience.

3. Transferability to Germany / Europe: Overall, we consider the possibility of a transfer of the approach (from Australia, New Zealand, Finland, Taiwan etc.) as given, because large urban agglomerations could be freed from COVID-19, too. The special issue of national border controls is discussed below.

4. Preservation of the green zones: Essential elements are the testing in strategic establishments with a high number of visitors, the risk-dependent opening of the public life according to clearly defined steps and the rapid, locally limited reintroduction of measures should infections flare up again.

The existence of a clear reopening plan was important for the morale and cohesion of Australia's citizens. This way, they could see the effectiveness of their own efforts through numbers and especially, finally, in the form of the loosening of restrictions. Such a roadmap can also be created quickly for Germany.

Reliable data from Australia are suitable for a first realistic assessment. Since the metropolitan regions pose an overall greater challenge, we summarize here the plan of Melbourne, a city of 4.3 million people and just under 500 inhabitants per sqkm (see Table 1). An earlier entry into the first step increases the effectiveness of the current lockdown.

The following estimates can be made for the required periods: From the current 150 cases per 100,000 per 7 days (IZ7) we can get to 10 cases per 100,000 in a few weeks if measures are enhanced and, above all, more consistently implemented. From that point on, Melbourne took another 4 weeks to get to a stable incidence of 0 (Green Zone status).

**Table 1. An example of the path to normality:
Roadmap of Melbourne, Victoria, Australia**

	Phase 1	Phase 2	Phase 3	Green Zone
	For 14 (cons.) days IZ7*<10	For 14 days IZ7<5	For 14 days IZ7=0	For 28 days IZ7=0
Social	<p>Curfew</p> <p>Leave home: only valid reason, Up to 5 people can meet outdoors, 2 households...</p> <p>Visitors to the home: 1 if living alone</p>	<p>No curfew</p> <p>No restrictions for leaving home</p> <p>Public gatherings: up to 10 people outdoors</p> <p>Visitors to the home: 1 household, up to 5 people</p>	<p>No curfew</p> <p>No restrictions for leaving home</p> <p>Public gatherings: up to 50 people outdoors</p> <p>Visitors to the home: up to 20 people, contact details</p>	<p>No curfew</p> <p>No restrictions for leaving home</p> <p>Public gatherings: no restrictions</p> <p>Visitors to the home: no restrictions, contact details</p>
Education, Childcare	<p>Daycare* open</p> <p>Schools remote learning, staged return for grade level 1 and 2</p>	<p>Daycare open</p> <p>Schools remote learning, staged return for grade level 3 to 10</p>	<p>Daycare open</p> <p>Schools remote learning, staged return for grade level 3 to 10</p>	<p>Daycare open</p> <p>Schools onsite learning</p> <p>Vocational Schools onsite learning</p>
Work	<p>permission of more workplaces according to industry roadmaps*</p>	<p>Home office, where possible</p>	<p>Home office, where possible</p>	<p>phased return to onsite work</p>

Note: exceptions for essential jobs and critical infrastructure. This is a condensed summary of a longer map

Border management and restrictions on mobility

The question of how the principle of free movement in the Schengen area is compatible with the zero-covid strategy is as crucial as it is difficult. Border closings and travel restrictions are among the measures to reduce mobility, which is why positive epidemiological effects can be expected from them. These measures may be difficult to enforce because of their social and economic side effects. At the same time, border controls have different effects depending on the epidemiological situation: their effect is strong a) as long as the epidemic is in an early phase and b) as soon as local transmission has been successfully prevented and the green zone status has been reached. In phases of rapid and uncontrolled local transmission, however, their effect is marginal.

From these considerations follows a procedure which ideally leads to the fact that renewed border closures within Europe can be avoided. In other words: closing the borders within Europe is not absolutely necessary for the success of the Green Zone concept.

At the present time, when the infection situation in most European countries is comparably high the intra-European borders could remain open. However the Federal Republic's shift to a NO-COVID strategy must be linked to a threefold message. First, it must continue to appeal to other European governments as well as to the European populations to limit travel activities to the bare minimum. Secondly, Germany must communicate that NO-COVID as a common European strategy is not only more effective, but also easier to implement. If other European countries also change their strategy at about the same time and are similarly effective in implementing the strategy, it will be easier for them to do so and are similarly effective in implementing it, this can have the collectively optimal result, that border control measures can be avoided. The decisive factor here is the effective combination of testing, contact tracing and quarantine; in the case of new outbreaks, only an immediate response can break all new chains of infection. Nationwide lockdowns will thus no longer exist.

Finally, countries following a No-Covid strategy need to be transparent in how they plan to deal with the situation if it is likely to be granted Green Zone status while its European neighbours continue to face higher incidences. In this case, the painstakingly achieved successes must be stabilised and re-entry of the virus from outside must be prevented. Different agreements will have to be reached with states that are in different epidemiological situations, whereby states with the same epidemiological situation would have to be treated equally. Border closures are the last resort - measures below this threshold (testing and quarantine of individuals, as well as reduction of mobility to essential mobility) may also be sufficient, provided that travel remains at a low level.

Minimise impacts on the economy

In order to minimise the negative consequences for the economy, work from home should be introduced as broadly and comprehensively as possible, wherever the job in question allows. Since it is associated with high fixed costs to close large factories and reopen them later,

sectors with a low risk of contagion, e.g. highly automated factories, and very high value added per employee (in particular manufacturing industry) should be allowed to continue production. To this end, companies must adapt their hygiene concepts to clinical hygiene standards. In addition, suitable protective measures (e.g. FFP2 masks/N95; ventilation technology; efficient testing strategies including pool testing) must be taken. In addition, home office/mobile work solutions must be implemented as far as practicable. If possible, individual transport should be used when travelling to the workplace, so that contacts are reduced wherever possible. Under these conditions, manufacturing companies can remain open as long as there are no SARS-CoV2 infections in the workplace, even if they are not in a green zone.

Safeguard measures for vulnerable groups and care facilities

The existing rules and regulations for protecting vulnerable groups, e.g. in the hygiene and (preventive) testing fields, are currently failing in many areas throughout Germany for the following reasons:

- 1) In the reality of care, regulations are not implemented comprehensively.
- 2) Hygiene plans in inpatient (care) facilities are usually only checked for their existence and in written form. There is a lack of unannounced on-site controls and implementation support. As an exemplary case, the reality check shows that break rooms are often used as if they were pandemic-free areas, but this tends to contribute to the spread of the virus.
3. Preventive testing concepts are often only formulated as an offer and not as an obligation. Even in the case of testing strategies, practical obstacles to implementation are only addressed in a well-structured way on a case-by-case basis
- 4) The frequency and quality of the required tests are often oriented towards compromise lines. However, the virus does not make compromises, but exploits them. For example, a rapid antigen test in care facilities with a frequency of 2 times per week does not offer any protective effect. Here, for example, either a PCR test would have to be used twice a week or a daily rapid antigen test for all visitors and employees (including canteen employees, cleaning staff).
5. FFP2/N95 masks for medical staff, cleaners and visitors are not available everywhere or for all staff. It should be noted that the protection of elderly populations has little impact on the development of the pandemic because they contribute less to the contacts.

Considerations on the legitimization of the NO-COVID strategy

A pure lockdown strategy without a sufficiently effective catalogue of measures does not meet the state's constitutional obligations towards its citizens. In contrast, the NO-COVID concept allows for a swift balancing of interests between all affected basic rights when very limited but significant fundamental rights restrictions are demanded, also due to its effectiveness of the measures used, which has already been proven in Australia and New Zealand:

The current imbalance of affected fundamental rights of various fundamental rights holders (i. a. Art. 1, 2, 4, 12, 14 GG) in the lockdown must be resolved quickly. When restricting fundamental rights, the constitutional requirement of commensurability of the measures applied must be satisfied. This is also necessary in order to exclude the possibility of state liability in the long term. In particular, since fundamental rights represent not only individual performance rights of the holders of fundamental rights to exercise these rights, but also protection rights derived from fundamental rights as an objective scale of values.

This commensurability includes the effectiveness of the measures applied. The current numbers from the RKI have been showing for weeks that the current lockdown is not sufficiently effective to sustainably control the pandemic in the foreseeable future. This is all the more evident when we look at the new SARS-CoV-2 variants, which are just spreading and are much more infectious. The situation will therefore predictably worsen if the transmission routes are not interrupted quickly and effectively.

According to current knowledge, the only demonstrably effective way to end this imbalance is the NO-COVID strategy. It aims at the responsibility of the state to end the overall negative impact of the SARS-CoV-2 pandemic in a prompt and effective manner with the available measures in such a way that the functioning of society in all its facets is maintained in the long run.

Structural responsibility in the state organization (only applicable in a German context)

It seems immediately reasonable to focus the emerging new tasks of a NO-COVID concept in the pandemic as far as possible on the competent authorities in charge of local community interests, to support them directly and to hold them responsible. This also supports the involvement of citizens for their own affairs. In combination with a reward system, this immediate responsibility can quickly lead to positive competition which would facilitate the expansion of Green Zones in Germany. Neighboring communities would immediately be in dialogue with each other and profit from positive competition and neighborly exchange. Managing tasks and accountability at this level would also put the need for border closings into perspective, as effective COVID management would be carried out on a small, understandable and effective scale.

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APPENDIX: Myths and Misunderstandings about SARS-CoV-2

Myth: There is a trade-off between health and economy

In the public discourse, health and economic interests are often depicted as opposing each other. However, that perspective has turned out wrong during other pandemics such as the 1918 Spanish Flu (Correia et al.). While stronger Containment measures did greater short-term damage to the economy, this was overcompensated by the shorter duration of measures and the earlier control of the pandemic. Thus, quick containment measures are not taken at the expense, but rather in the interest of the economy. Quantitative examination by HZI and the German Ifo Institute (Dorn & Khailaie et al) show that a perpetuation of measures such as the ones being taken in Germany since October 2020 not only leads to more deaths but also causes the largest economical damage.

Myth: We can protect vulnerable groups

The publication from Brasil cited above (Buss et al.) has shown that the virus has spread evenly throughout the population rather than being limited to certain stronger-exposed subgroups. This is in agreement with other global insights, indicating that it is practically impossible to "protect" the vulnerable or to implement "targeted protection", as it is difficult to discriminate and divide between healthy, vulnerable (Alwan et al.). In a situation of unlimited transmission the infection will inevitably spread to vulnerable groups, which will lead to the corresponding damage (Richmond et al.). We observe this development in Germany as well as basically all other countries that have chosen the way of mitigation. Additionally, Germany has a very high percentage of elderly and vulnerable people (Assumed around 40%; 22% of the population are 65 years or above; additionally there are patients with diseases such as cancer, drastically increasing the lethality of COVID-19).

Myth: COVID-19 only concerns the elderly

Even within a younger population, SARS-CoV2 is harmful and deadly. Increasing evidence for long-term multisystemic consequences from COVID19 indicates a significant morbidity after the infection (Galeotti & Bavry; Iacobucci et al.; Huang et al.). Even in young age groups the risk cannot be ignored (Diorio et al.). This illustrates the risk of exposing large parts of the population to a virus of which there is still a lot unknown or poorly understood. In light of the significant repercussions of poor health within these groups for the society as a whole, strategies for the suppression of COVID-19 cannot be limited to the elderly or people with comorbidities, but must aim at protecting the population as a whole.

Myth: Once infected, forever immune

It is still unclear how long SARS-CoV-2 immunity lasts and how high the risk of reinfection is (Iwasaki et al.). Seasonal coronaviruses leading to common cold are known to induce short-term immunity and reinfections typically within 12 months after infection (Edridge et al.), even though immunity against SARS-CoV and MERS-CoV (both of which cause serious symptoms) can last a few years (Huang et al.). T-cell immunity might last longer, however it is unclear whether it exceeds 1-2 years (Le Bert et al.). If immunity decreases, this would mean that recurring epidemic cycles are probable, especially if new viral strains arise which can evade immune recognition.

Myth: Only the vaccination will save us

Even though the duration and effectiveness of vaccine-induced immunity with respect to transmission reduction is still unclear, experience from various infectious diseases indicates that immunity could be amplified through vaccination. Yet there is a global need for vaccines and we will not be able to vaccinate enough people in the coming 6-9 months in order to avoid more dramatic waves of infections. On top of that, it is still unclear vaccine-induced immunity lasts for more than 1-2 years. Thus, the pandemic should be stopped within this timeframe.

Myth: Herd immunity can be achieved by infection

Results of a new publication from Brazil (Buss et al.) explicitly show that striving for herd immunity by natural infection is not a feasible strategy in this pandemic. Achieving herd immunity this way is not only very costly with respect to mortality and morbidity, but also has very limited chance of success. Even though Manaus, Brazil, already had a very high rate of infection (around 70%), there is a raging second wave. A strategy which allows the virus to spread throughout the population and which aims at keeping hospitalizations just below the health system's capacities, as is the case for influenza, is impossible for SARS-CoV-2. Just like SARS-CoV and MERS-CoV, SARS-CoV-2 must be met with an aggressive strategy of suppression (Han et al.). Governments must concentrate on precise, non-pharmaceutical measures, robust testing/tracing/isolation systems, border control measures, mass testing, improved treatment as well as the development and supply of vaccines (Han et al.). This is the most sustainable and least costly way out of the pandemic.

Myth: Closing schools is more stressful for children and families than keeping them open

The uncertainty of the current situation has shown to be the most important source of stress for families. It is expressed as negative economic consequences, fear of the unpredictable quarantine measure, recurring restrictions for an unpredictable time, fear of infection or fear of increased health risk from other conditions.

Contrary to popular belief, the 'narrowness' induced by lockdown measures is not such a significant risk factor, but turns out to be a fairly low risk event if adequate resources are provided. Some families may be at higher risk than others due to health or economic reasons, and thus will require additional targeted interventions and active support.

If the incidence is high and educational institutions are open, unexpected quarantines may occur very frequently, which may have a larger, more damaging psycho-social effect on families than a structured lockdown with a set duration and clear criteria for lifting restrictions. Approx. 25-30% of all families experienced a problem with a quarantine, according to international surveys (some as high as 33-35%). One survey is ongoing at the FFH Düsseldorf, but is showing similar results.

The development of children, especially adolescents, is currently hindered by the social constraints of the pandemic. Open schools and daycare centers are only a small relief to most families, especially when the social experiences are highly limited: group interactions are not advised, social distancing measures are in place, singing is prohibited, etc. The impact on children and families of long, repeated and half-hearted lockdowns is unknown and is yet to be quantified.

Well-organized and goal-oriented support and a precise didactical analysis can compensate for the effects of a time-limited, structured suspension of face-to-face teaching both for the overall education of young people as well as certain risk groups (children in poverty, children with special needs, children with linguistic needs). This requires the development of certain didactical structures that are already well-known in the corresponding subject areas. The discussion on opening ("yellow" and "green zones") can and must examine and implement transition measures (prioritization of families in special circumstances, continued digital practise phases (comprising almost 40% of lessons), protection plans in schools (particularly quick and wide-ranging testing to prevent long quarantines).

Myth: Vaccinations will end the coronavirus pandemic quickly

If the previous strategy of repeated lockdowns is simply pursued, then we expect the intensive care units to remain heavily occupied until nearly all adults are adequately vaccinated. With the expected 25 million vaccinations by June, that means the intensive care units will be fairly full and have little relaxation until July/August. Hopefully, by then, we will have enough vaccines to be able to offer vaccination to everyone who wants to be vaccinated.

The seasonal effect that many hope for reliably ends the flu season in spring. However, the influenza virus only has an R-value of around 1.1 to 1.3. SARS-CoV-2 has a much higher R-value. The expected seasonal effects of around 20% are far from sufficient to slow down the pandemic significantly (Carlson et al.). The fact that SARS-CoV2 was suppressed so quickly and effectively last spring was mainly due to the synchronized lockdown across Europe. It is not to be expected that infections go down on their own in March.

Myth: Germany is not Australia, not an isle, not a totalitarian regime ...

Bavaria is not Thuringia and East Berlin is not West Berlin...The fact that countries with very different political and geographical structures have managed the crisis, is evidence that the various ways lead to the same goal of No-Covid. Besides, you should learn from the best and - if necessary - the worst. Taiwan, Singapur, Australia and New Zealand manage the pandemic

very well, the US didn't. Australia, for instance, would be a country to learn from easily. What were the obstacles and how did they tackle them? They have a federal system, with state borders larger than Bavarias and with Sydney and Melbourne cities larger than Munich. Its a waste and very unscientific to reject all the knowledge they have gathered. You evaluate and transfer as much as possible and for the remaining open questions (e.g. the land borders) you come up with new concepts or you to put it differently, if you are more leaky in one way (e.g. at your border) you have to do better in other ways (e.g. testing or masks). You need a set of tools to filter out the virus and use the combination of those filters wisely.

Literature

Alwan et al., Lancet 396, e71 (2020)

Buss et al., Science 371, 288 (2021)

Carlson et al., Nat Commun 11, 4312 (2020)

Correia, Luck, Verner, SSRN (2020), doi: 10.2139 / ssrn.3561560.

Diorio et al., Blood Adv. 4, 6051 (2020)

Dorn, Khailaie, et al. <https://www.medrxiv.org/content/10.1101/2020.08.14.20175224v1>

Edridge et al., Nat. Med. 26, 1691 (2020)

Galeotti & Bayry et al, Nat. Rev. Rheumatol. 16, 413 (2020)

Han et al., Lancet 396, 1525 (2020)

Huang et al., Nat. Commun. 11, 4704 (2020)

Huang et al., The Lancet, ahead of print (2021): doi.org/10.1016/S0140-6736(20)32656-8

Iwasaki, Lancet Infect. Dis. 10.1016 / S1473-3099 (20) 30783-0 (2020)

Le Bert et al., Nature 584, 457 (2020)

Iacobucci, BMJ 371, m4470 (2020)

Richmond et al, medRxiv 20210294 (2020)