ECDC INTERNAL DOCUMENT

Communication

ECDC lines-to-take

COVID-19 Vaccination and Prioritisation Strategies

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Background

Since December 2019 and as of December 2020 there have been over 15 000 000 cases of COVID-19 reported in the EU/EEA and the UK, including over 375 000 deaths. All EU/EEA and UK countries have reported COVID-19 cases, but the spread of the outbreak and the number of infected vary within and between countries. Most of EU/EEA countries and the UK are experiencing a second increase of cases during these autumn/winter months. Although the number of performed tests is higher than those carried out during the spring 2020, the high and rising positivity rate show this is a real increase in which the social, personal and economic impact for the population has to be considered.

In the absence of a specific curative treatment or a vaccine, non-pharmaceutical interventions (NPI), such as physical distancing, have so far been used to curb the pandemic. There are however concerns about the long-term sustainability in terms of population acceptance and compliance with following such preventive measures, and of the potential social and economic consequences. In addition to NPIs, the development and use of safe and effective vaccines against COVID-19 is considered the most promising option for containing the pandemic in the long term.

It is expected that the initial supply of COVID-19 vaccines will be limited. Therefore, it will be very important for countries to identify priority groups to be vaccinated in a first phase, before moving to subsequent phases in which vaccines presumably can be offered to an increasingly larger part of the population, possibly on a routine basis. The process of prioritising which groups to vaccinate in the initial phase needs to be fair, transparent and continuously updated, based on new available knowledge. Countries will also need to develop comprehensive vaccination strategies in line with their public health objectives, also taking into account incidence, burden and geographical distribution of COVID-19. These strategies will need to be adapted over time to epidemiological changes, new evidence on disease pathogenesis and risk groups, vaccine supply, and new knowledge on safety, immunity and protection from the available vaccines.

Mathematical modelling is important for supporting the identification of priority groups for vaccination against COVID-19 and the development of efficient and effective vaccination strategies. By using data on demography, COVID-19 epidemiology, and prevalence of risk groups in the population, mathematical modelling can be utilised to compare the potential impact of different vaccination strategies targeting different groups based on assumptions on vaccine characteristics, vaccine supply and uptake. Mathematical modelling alone is unable to provide a single answer on what is the best strategy to adopt for the roll-out of COVID-19 vaccination. However, it can provide insight on some of the most influential factors for decision-making according to different scenarios and public health objectives.

Scope of this document

This document builds on a previously published ECDC report on "Key aspects regarding the introduction and prioritisation of COVID-19 vaccination in the EU/EEA and the UK". By using mathematical modelling, this document provides EU/EEA countries with information on factors that may affect the choice of COVID-19 vaccination strategies, according to different target groups and based on scenarios of hypothetical vaccine characteristics.

The objectives of this document are to show:

- how the objective of a vaccination strategy should be informed by the characteristics of the vaccines available;

- how prioritisation of certain population groups may help to achieve the objective of the vaccination strategy.

Questions

1) Who is this document for?

The target audiences for this document include public health institutes and professionals involved in the COVID-19 vaccination planning, national immunisation technical advisory groups (NITAGs), Ministries of Health and other decision-making bodies involved in the planning of COVID-19 vaccination campaigns at national as well as subnational level.

2) How does this model work?

In brief, the model simulates the transmission of SARS-CoV-2 in the EU/EEA and the progression to COVID-19 disease, including mild cases which remain in the community and severe cases which are admitted to standard hospital wards or to intensive care units. It is age-structured, accounting for the differential risk of severe disease and death by age.

The model incorporates data on non-pharmaceutical interventions and testing rates over time since February 2020 and is calibrated to available data on number of confirmed cases, hospital admissions, ICU admissions and COVID-19 deaths for each member state of the EU/EEA. In this analysis, the model is fitted to epidemiological data up until 1 December 2020 to simulate the background naturally acquired immunity. We model the whole EU/EEA population.

3) How definitive is this model?

The objective of this analysis is to compare the relative effectiveness and efficiency of different vaccine prioritisation strategies by target group. This analysis is not intended to make a forecast of how COVID-19 epidemiology will evolve in the EU/EEA in the vaccination era. The latter will depend on vaccine characteristics, future policy on non-pharmaceutical interventions and other behavioural change. We model an artificial scenario of steady ongoing transmission as a 'testground' for exploring the factors that will influence vaccination policy. In the baseline analysis, we make the limiting assumption that naturally acquired immunity lasts longer than 24 months.

We simulate the introduction of a number of different vaccination strategies comparing each with a universal vaccination strategy where all adults are vaccinated. To illustrate the factors that may drive prioritisation, we assume in the baseline scenario that the whole target group is vaccinated on the same day i.e. that there is adequate supply and 100% uptake. We assume two vaccine doses are required per person. The impact of vaccination is assessed as the total number of deaths prevented, life years saved and hospital and ICU admissions prevented in one year following the date of vaccination.

We model alternative vaccine characteristics. If the vaccine prevents infection, the vaccinee becomes immune.

If the vaccine prevents mild disease then, if infected, the vaccinee has an asymptomatic infection. Individuals with asymptomatic infection are assumed to transmit the virus 35% as effectively as symptomatic individuals. We assume that in the pre-vaccination era, 17% of cases are asymptomatic. If the vaccine prevents severe disease then, if infected, the vaccinee has a mild clinical presentation. We assume that cases with a mild clinical presentation reduce their contacts by 75% after diagnosis, cases with severe presentation (equivalent to hospitalisation) are assumed to be isolated after diagnosis.

4) What other assumptions are taken into account?

Our baseline analysis assumes that the vaccine is 95% effective at preventing severe disease in healthy adults, with protection lasting at least 12 months. The efficacy against severe disease is lower (70%) in adults aged 60 and over and in those with relevant medical preconditions. The efficacy against clinical disease of any severity is 50% in healthy adults and 30% in older adults and those with preconditions. In the baseline analysis we assume no efficacy against infection and therefore onward transmission. However, we do consider alternative scenarios where the vaccine has an efficacy of 20% or 50% against infection and a subsequently higher efficacy against clinical disease.

For each strategy, we present its effectiveness in terms of deaths averted, life years saved and hospital and ICU admission averted, compared with a strategy of vaccinating all adults. We also present the efficiency of each strategy for each of these measures i.e. the relative impact of one dose of vaccine, compared with a universal strategy. The full table of results is presented in Appendix 1 of the report.

5) Why should vaccination schedules be organised by age group?

Based on individual country data and depending on vaccine availability, countries may consider targeting first older age groups with increased risk of hospitalisations, ICU admissions and death from COVID-19.

The risk of COVID-19 hospitalisation, ICU admission and death increases steeply after the age of 60 years. Even if a vaccine were less efficacious at preventing disease in older people, the disproportionate burden of morbidity and mortality in this group means that vaccination is beneficial. In terms of preventing death, vaccination of the oldest individuals (those over the age of 80 years) is the most efficient use of a vaccine. However, given that they have shorter life expectancy, the most efficient choice in terms of life years saved is to vaccinate people aged 60 years and over.

Vaccinating according to age group is a practical approach, and easy to communicate. It is historically associated with good vaccine uptake and can be considered an efficient and pragmatic option to reduce COVID-19 morbidity and mortality if vaccine supply is insufficient to vaccinate the whole population.

Epidemiological and demographic data and vaccine supply will contribute to drive decisions on which age groups to target in each country. As age structures differ across EU countries, there will likely be a variation on the age limits for vaccination of older adults in different countries.

6) Should those with preconditions take the vaccine?

Individuals with certain underlying health conditions (preconditions) have higher morbidity and mortality from COVID-19 compared to healthy persons. The preconditions significantly associated with COVID-19-related hospitalisation, ICU admissions and death include diabetes mellitus, chronic cardiovascular disease, chronic respiratory disease, chronic kidney disease, immunocompromised states (e.g. organ transplant), cancer, chronic liver disease, certain neurological disorders, trisomy 21 and sickle cell disease. The individual risk of hospitalisation and death increases with the number of preconditions. **However, singling out all individuals with relevant underlying health conditions may be challenging or controversial**. As knowledge about risk factors for severe COVID-19 is still growing, the causality and magnitude of risk from each of these underlying medical conditions should be monitored and periodically reviewed.

On the other side, targeting individuals with preconditions well known to be associated with increased risk of severe COVID-19 disease may be an efficient approach to reducing hospital admissions, ICU admissions and mortality. It should be noted that the efficacy, safety and immunogenicity of the vaccine has not been assessed in immunocompromised individuals, including those receiving immunosuppressant therapy. The efficacy of vaccines may be lower in immunosuppressed individuals..

The proportion of adults aged over 70 who have at least one precondition known to be associated with severe COVID-19 disease is high (76.8%). For this reason, we combine our analysis of prioritisation of vaccination by preconditions with age-targeted strategies.

7) Should healthcare workers be prioritised as well?

Based on the current model, if vaccination against COVID-19 protects against infection and therefore transmission, vaccinating healthcare workers will provide indirect protection to individuals who are hospitalised or residing in long-term care home facilities, as well as those individuals who cannot be vaccinated due to certain health-related issues. Thus, early vaccination of healthcare workers would have dual benefit.

If vaccination against COVID-19 only protects against symptomatic disease, and not against infection, the impact of vaccinating healthcare workers will be reduced as it will be limited to direct protection of healthcare professionals (including those at risk of severe COVID-19). Vaccinating healthcare workers will then mainly aim at protecting them from severe COVID-19 and at maintaining staff availability during phases of high community transmission but will not indirectly protect patients or residents of long-term healthcare facilities.

Prioritising healthcare workers for vaccination is of particular importance during outbreaks in healthcare settings or when there is widespread community transmission, especially when the pressure on healthcare is high and increasing. During a low community transmission phase of the pandemic, attention should be naturally shifted more towards individuals at highest risk of developing severe COVID-19.

Considerations should be given to prioritisation of healthcare workers based on individual exposure, risk of transmission to patients (if the vaccine confers indirect protection), and individual risk of severe COVID-19 due to age, preconditions or other conditions.

8) What are the considerations for those not in risk groups previously mentioned?

Given the practical challenges of targeting younger adults (aged 18-59), it is unlikely that this approach will be part of a COVID-19 strategy in the initial phase where supply is limited. If a vaccine is unsafe or inefficacious in older adults and those with underlying conditions, a programme of indirect protection could be considered. This approach would reduce COVID-19 morbidity and mortality, only if the vaccine prevents infection and therefore onwards transmission. Otherwise, vaccination of adults 18-59 years of age should not be considered as an optional strategy in the initial phases of COVID-19 vaccine deployment. It is possible that some specific groups or occupations more at risk of exposed to the virus can be identified and considered in certain settings and contexts. However, in general, other approaches should be prioritised in the context of initial limited supply or in case the COVID-19 vaccines showed very limited efficacy against SARS-CoV-2 infection and onward transmission. Vaccinating all adults 18-59 years of age with a vaccine effectively preventing transmission is a potential approach for reducing viral circulation and reach disease control. However, it is not the most rapid, effective and ethical way of reducing hospitalisations and deaths in groups at increased medical risk of severe COVID-19.

9) Should universal vaccination programmes be considered?

Paediatric trials are still ongoing, and in the initial phase vaccines will only be authorised for use for those 16 years and older. For those above 16 years old, universal vaccination could be considered the most equal approach, albeit assuming enough vaccine doses available for everyone who can get vaccinated. Unfortunately, this is unlikely to be the case for several months following the introduction of COVID-19 vaccines into the market, as vaccine supply is foreseen to be limited in the presence of a large global demand.

If the available COVID-19 vaccines are effective against SARS-CoV-2 infection and onward transmission, universal vaccination would lead to a strong reduction of viral circulation in the whole population, and may eventually lead to herd protection, depending on the vaccine efficacy and the duration of protection. A vaccine efficacious against SARS-CoV-2 infection and onward transmission will also indirectly protect individuals who cannot be vaccinated. If a high vaccination coverage is sustained over time with high vaccine efficacy and long duration of protection, universal vaccination will also make possible to set COVID-19 elimination goals. COVID-19 eradication is not considered a feasible goal due to the existence of non-human reservoirs of SARS-CoV-2.

If the COVID-19 vaccine is only able to prevent symptomatic disease (and not infection and onward transmission), universal vaccination will not be able to effectively lead to indirect protection and herd immunity.

Additionally, since different groups of the population may respond differently to the vaccines, it is important to closely monitor the safety and effectiveness of the available COVID-19 vaccines.

As the duration of protection from vaccination against COVID-19 is currently unknown, a short duration of protection will imply the need for re-vaccination of a very large numbers of individuals with massive implications for vaccine production, procurement, supply and logistics.

Finally, universal vaccination, involving tens of millions of individuals over a relatively short period of time, could increase the risk of reporting adverse events non-causally associated with vaccination. This has the potential to undermine COVID-19 vaccination acceptance and uptake, as well as vaccination confidence in general.

10) Will there be enough available vaccines for universal coverage?

Vaccinating everyone comes at a very high price in terms of time, cost, resources and logistics. Supply will not be sufficient to vaccinate everyone for many months after the introduction of the vaccines against COVID-19, so the implementation of a universal vaccination is not considered feasible during at least the first half of 2021. Additionally, with a universal vaccination, there would be more concerns about vaccine uptake, in particular among people not at heightened risk of severe disease. This may lead to several pockets of unvaccinated individuals in the population that cannot be traced or reached without proper and well-functioning immunisation information systems in place.

After an initial phase of limited supply, universal vaccination is the preferable strategy only if the vaccine is very safe and effective, protects against infection and onward transmission, and induces a sufficiently long duration of protection.

11) How long does protection last?

The current estimates on vaccine efficacy are based on short follow-up after vaccination, so it is currently unclear what the duration of protection of each vaccine will be.
As COVID-19 is still a new disease, there are also many unknowns related to protective immunity following natural COVID-19 infection. At this stage for example, we do not know for sure how long people are immune after clearing an infection or how long they will be following vaccination.

Current observations show that SARS-CoV-2 specific antibodies wane within 3 to 6 months in many people that were (naturally) infected. Until we know more about the possible immunological correlates of protection, i.e. what is needed to be in place for protection, it is difficult to estimate what an observed vaccine-induced immune response translates into. It could well be that vaccination in regular intervals is needed, similar to the annual flu vaccine.

COVID-19-reinfections have been observed, but it is currently unknown how common they are. Many are milder than the primary infection but not all. In addition, eradication is very difficult to achieve for diseases that have an animal reservoir like SARS-CoV-2.

In our baseline analysis, we assume that duration of vaccine protection is longer than the timeframe we consider. As vaccine protection wanes, more doses will be needed to maintain immunity. A strategy that relies on indirect protection is more resilient to waning immunity than a direct protection strategy. If the virus were to mutate substantially, a higher proportion of the population would be susceptible and vaccine efficacy may be reduced. In this case, the effectiveness of any vaccination programme would be diminished.

12) If someone has had Covid-19, should they get the vaccine?

People with previous COVID-19 infection were not excluded from Phase 3 trials, and there is no current evidence of harm or absence of efficacy. As the exact duration of natural immunity from COVID-19 infection is currently unknown, at this stage it is advisable not to exclude people with previous COVID-19 infection from vaccination. Nevertheless, these aspects need to be followed up and updated according to the emerging evidence.

13) Should those under 18 be vaccinated?

There is limited data available about vaccine safety and efficacy in adolescents 12-18 years old. However, some phase 3 trial included also a number of individuals aged 16 years and over. For this reason, many regulators, including EMA, have given conditional marketing authorisation for the Pfizer/BioNTech vaccine from the age of 16.

14) With vaccines rolling out, can NPIs be reduced?

As vaccine supply will not be immediately enough for all people in the target groups for vaccination, the impact of any vaccination strategy will not be initially sufficient to lift non-pharmaceutical interventions. More clarity in the coming months about different vaccines characteristics (number of doses needed, interval in-between doses, reactogenicity and safety, effectiveness in different groups and against different endpoints, duration of protection) and trends in vaccine supply, deployment and uptake will help Member States decide when and how to lift non-pharmaceutical interventions. Vaccination strategies will thus need to be adaptable and data driven. We recommend that non-pharmaceutical interventions continue to be applied for the time being.