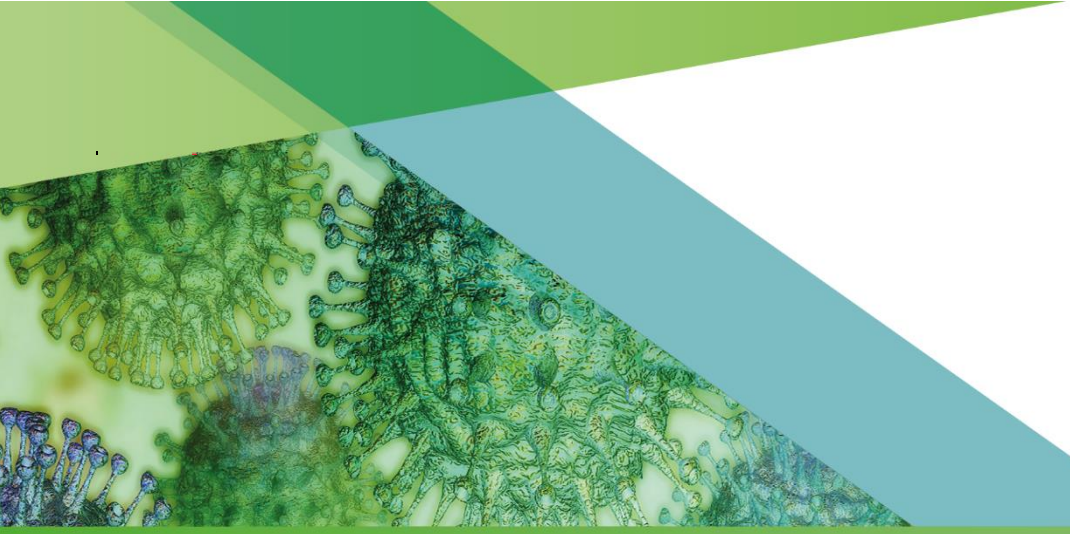

TECHNICAL REPORT

Contact tracing in the European Union: public health management of persons, including healthcare workers, who have had contact with COVID-19 cases – fourth update

28 October 2021

Key messages

- Contact tracing is an essential public health measure to fight the ongoing COVID-19 pandemic, in conjunction with active case finding and testing, and in synergy with other measures such as physical distancing. The purpose of identifying and managing the contacts of a COVID-19 case is to support early diagnosis and to interrupt onward transmission through the rapid identification and management of secondary cases that may arise after transmission from the primary case. This is achieved through:
  - prompt identification of the contacts of a COVID-19 case;
  - providing contacts with information on self-quarantine, proper hand hygiene and respiratory etiquette, and advice around what to do if they develop symptoms;
  - testing all high-risk exposure contacts, whether vaccinated or not, as soon as possible after they have been identified to allow for further contact tracing;
  - testing all unvaccinated low-risk exposure contacts; and
  - testing all contacts that become symptomatic.
- Each country should adapt their response to the local epidemiological situation and available resources. The rigorous and timely application of contact tracing measures in areas where there are a limited number of cases can play a key role in limiting further spread of the outbreak. However, if resources allow, contact tracing should also be undertaken in geographical locations with more widespread transmission.

What is new in this document?

- Considerations relating to new developments since the last update, including:
  - vaccination against SARS-CoV-2 has been rolled out across EU/EEA countries,
  - several new variants of concern (VOCs) have emerged, and
  - evidence on transmissibility of the B.1.617.2 (Delta) variant and on vaccine effectiveness is now available.
- Differentiation between the management of vaccinated contacts versus unvaccinated contacts.
- Revised recommendations for contact tracing in the school setting.

Suggested citation: European Centre for Disease Prevention and Control. Contact tracing in the European Union: public health management of persons, including healthcare workers, who have had contact with COVID-19 cases – fourth update, 28 October 2021. Stockholm: ECDC; 2021

European Centre for Disease Prevention and Control. Stockholm, 2021.

Scope of this document

This document aims to help public health authorities in European Union and European Economic Area (EU/EEA) countries in their tracing and management of persons, including healthcare workers (HCWs), who have had contact with COVID-19 cases. Contact tracing should be implemented in combination with non-pharmaceutical measures as appropriate [1].

This document outlines the key steps for contact tracing in the context of the COVID-19 response, including contact identification, advice, and follow-up. Contact management is based on the latest available evidence on COVID-19, as outlined below.

Background

Contact tracing is an essential public health measure to fight the ongoing COVID-19 pandemic, in conjunction with active case finding and testing, and in synergy with other measures such as physical distancing. Data collected through contact tracing also contributes to a better understanding of the epidemiology of COVID-19.

Detailed information on SARS-CoV-2 can be found on the ECDC website [2,3] and the latest information on the epidemiological situation in the EU/EEA can be found on the ECDC weekly surveillance pages [4,5].

Delta variant of concern

Countries have observed substantial increases in the number and proportion of SARS-CoV-2 cases infected with VOCs, with the Delta variant currently dominating in EU/EEA countries [6]. There is epidemiological evidence that the Delta variant is more transmissible than the ancestral and B.1.1.7 (Alpha) strains, with transmissibility nearly double that of the wild-type SARS-CoV-2 virus that circulated during autumn 2020 [7-12], which may have played a key role in the rapid dominance of the Delta variant.

The median incubation period of COVID-19 has so far been considered to be five to six days, with the majority of symptomatic cases having symptom onset between 2 to 12 days after exposure and around 95% of symptomatic individuals displaying symptoms by day 14 [13]. A few studies have assessed the virological characteristics of the Delta variant; recent studies looking at the incubation period suggest that patients infected with the Delta variant may have more rapid symptom onset and a shorter incubation period [14-19]. One study showed that the 95th percentile of the incubation period for Delta was 11.5 days [14]. So far, it is unknown if the incubation period for the Delta variant differs between vaccinated and unvaccinated individuals who become infected.

The exact duration of infectiousness of COVID-19 cases (the period during which they can transmit the virus to others) may vary between variants and by vaccination status [20]. For the Delta variant, current evidence suggests that it causes higher viral loads and more prolonged duration of viral RNA shedding (up to 18 days) than previous variants [14,21,22]. It needs to be noted, however, that viral RNA shedding indicates the presence of viral genetic material but does not always indicate infectiousness. Early findings from two studies have estimated that infected individuals are most infectious during the early stages of infection, with peak infectiousness at 2.1 days before symptom onset, and have observed that they maintained high viral loads for up to seven days after symptom onset [14,15]. So far, studies have indicated that patients with mild-to-moderate COVID-19 symptoms are unlikely to be infectious for more than 10 days after symptom onset [23].

Please refer to the ECDC website, which will be updated as new information on Delta emerges.

Vaccine effectiveness

Since the previous update of this guidance, vaccination against SARS-CoV-2 has been rolled out across EU/EEA countries and several variants of concern (VOCs) have emerged. The evidence base for vaccine effectiveness is rapidly evolving, particularly in relation to the level of protection that full vaccination with COVID-19 vaccines provides against infection, severe disease, and hospitalisation due to the Delta variant. Current evidence indicates a decrease in vaccine effectiveness against SARS-CoV-2 infection with the Delta variant compared to the wild-type or Alpha variants [24]. However, the impact of the Delta variant on vaccine effectiveness against severe disease, hospitalisation and death is less pronounced, with effectiveness equivalent to wild-type or Alpha variants, with the exception of certain vulnerable groups (e.g. persons >65 years old) [25,26].

Recent studies on the Delta variant indicate that the viral loads are similar in vaccinated and unvaccinated individuals who are infected, although it is important to note that the risk of getting infected is less for fully vaccinated individuals. However, recent evidence also suggests that viral loads in fully vaccinated individuals infected with the Delta variant decline more rapidly than viral loads in unvaccinated individuals infected with the Delta variant, and that vaccinated individuals might clear the infection more rapidly [27-29].

Recent evidence indicates that vaccine effectiveness against transmission in fully vaccinated individuals is reduced for Delta infections compared to Alpha infections. However, two doses of Comirnaty, Spikevax or Vaxzevria still substantially reduce the risk of onward transmission compared to no vaccine doses [30].

In terms of cycle threshold (Ct) values, most studies have described no difference in Ct values between vaccinated and unvaccinated individuals who are infected [21,27,29,31]. A Ct threshold has been used as a marker for infectiousness; however, viral RNA can still be released by infected cells in the absence of infectious virions and a correlation between Ct value and infectiousness still needs to be established. Viral viability is considered a better proxy for infectiousness in a specimen. While there are reports suggesting a reduced probability of detecting infectious virus in vaccinated compared to unvaccinated infected individuals despite similar Ct values [29,32], this evidence has not been substantiated elsewhere [21,32]. Further evidence is needed to determine the likely duration of infectiousness of vaccinated individuals who become infected, but emerging data suggest a reduced duration of infectiousness in vaccinated compared to unvaccinated individuals [24].

It is difficult to disentangle if reductions in effectiveness against SARS-CoV-2 infections over time are due to waning immunity or the Delta variant escaping vaccine protection. Duration of immunity is a complex issue and the correlation between measured immunity and clinical protection from SARS-CoV-2 infection still needs to be further established.

Clinical trial data indicate that vaccine efficacy of Comirnaty against infection remains high for up to six months after one is fully vaccinated, although it gradually declines during this period. The follow-up of the Spikevax efficacy trial shows that neutralising antibodies gradually decline over time, but they remain detectable at least six months post vaccination [33]. However, the presence of neutralising antibodies is only one indication of protection against infection in vaccinated individuals, as less is known about the protection provided from memory B and T cells.

Observational studies have provided evidence of waning immunity against SARS-CoV-2 infection ≥5 months after full vaccination, but vaccine effectiveness continues to be strong against hospitalisation and severe disease [34,35]. However, this needs to be carefully monitored over time, particularly among those aged 65 years and older, as some signs of decreased protection against hospitalisation in this age group have now been reported by some countries [25,26,34,36,37].

Persons previously infected

The risk of subsequent infection and onward transmission in those who have been previously diagnosed with SARS-CoV-2 infection is not completely understood and evidence is still emerging [38]. A systematic review of 11 pre-Delta studies conducted by the Health Information and Quality Authority in Ireland suggests that reinfection risk among recovered individuals is low (absolute rate: 0–1.1%), with protection maintained for up to 10 months post initial infection [39]. Preliminary analysis of national surveillance data from the United Kingdom (UK) indicates that recovered individuals have an increased risk of reinfection with Delta compared to the previously dominant Alpha strain, with overall odds around 46% higher. However, this risk was only elevated for those with a prior infection ≥180 days earlier and, in absolute terms, the risk of reinfection with Delta remained low at approximately 1% [40].

Available evidence suggests that the risk of reinfection for a person who has recovered from a COVID-19 infection (even if mild or asymptomatic) can be considered low if the subsequent COVID-19 exposure takes place within three months of their initial diagnosis [39,41]. Thereafter, the virus neutralising capability of serum from recovered individuals gradually decreases [42].

Principles of contact tracing

The purpose of identifying and managing the contacts of a COVID-19 case is to support early diagnosis and to interrupt onward transmission through the rapid identification and management of secondary cases that may arise after transmission from the primary case. This is achieved through:

- prompt identification of the contacts of a COVID-19 case;
- providing contacts with information on self-quarantine, proper hand hygiene and respiratory etiquette, and advice around what to do if they develop symptoms;
- testing all high-risk exposure contact persons, whether vaccinated or not, as soon as possible after they have been identified to allow for further contact tracing;
- testing all unvaccinated low-risk exposure contacts; and
- testing all contacts that become symptomatic.

To ensure optimal effectiveness of contact tracing, the importance of seeking testing immediately upon appearance of symptoms should be stressed to the public and testing should be easily accessible to everyone. Furthermore, tests should be processed quickly so that contact tracing can be carried out as soon as possible following a positive test result, ensuring that the quarantine of contacts is effective and further transmission is prevented. This is particularly important in the context of the Delta variant, due to its increased transmissibility.

When to carry out contact tracing

Each country should adapt their response to the local epidemiological situation and available resources. The rigorous and timely application of contact tracing measures in areas where there are a limited number of cases can play a key role in limiting further spread of the outbreak. However, if resources allow, contact tracing should also be undertaken in geographical locations with more widespread transmission. Even if not all contacts of each case are identified and traced, contact tracing is still thought to contribute to reducing transmission in combination with other non-pharmaceutical interventions [43,44]. Contact tracing efforts should always aim to cover at least cases occurring in high-risk settings such as long-term care facilities, hospitals, prisons and refugee camps to reduce transmission and mitigate the impact on vulnerable populations. Contact tracing can also help prevent emerging VOCs from becoming established.

Definition of the term 'contact' person

A contact of a COVID-19 case is any person who has had exposure to a confirmed COVID-19 case within a time frame ranging from two days before symptom onset in the case to 10 days after symptom onset [23]. If the case has severe symptoms or is immunocompromised, consider extending this range to up to 20 days after symptom onset in the case. Emerging evidence from a preprint study indicates that cases infected with the Delta variant can transmit infection earlier than two days before showing symptoms; this is discussed in the 'Options for enhanced contact tracing' section. The associated risk of infection depends on the level of exposure, which determines the type of management that is appropriate. If the case has had no symptoms, further assessment should take place, as outlined in the 'Contact tracing for asymptomatic cases' section below.

Table 1. Classification of contact based on level of exposure

High-risk exposure contact (close contact)	Low-risk exposure contact
A person who has had one or more of the following exposures: Face-to-face contact with a COVID-19 case within two metres for more than a total of 15 minutes over a 24-hour period (even if not consecutive) • Physical contact with a COVID-19 case • Direct contact with infectious secretions of a COVID-19 case (e.g. being coughed on) • Being in a closed environment (e.g. household, meeting room, hospital waiting room, etc.) or travelling* with a COVID-19 case for more than 15 minutes • Being a healthcare worker** or other person providing direct care*** to a COVID-19 case or a laboratory worker** handling specimens from a COVID-19 case, without wearing the recommended PPE or with a possible breach of PPE or hand hygiene [45].	A person who has had one or more of the following exposures: • Face-to-face contact with a COVID-19 case within two metres for less than 15 minutes • Being in a closed environment (e.g. household, meeting room, hospital waiting room, etc.) or travelling* with a COVID-19 case for less than 15 minutes • Being a healthcare worker** or other person providing direct care*** to a COVID-19 case or a laboratory worker** handling specimens from a COVID-19 case, wearing the recommended PPE and performing appropriate hand hygiene [23].

** For further details relating to contact tracing for cases travelling on an aircraft or cruise ship, see Annex 1 in previous guidance [46]. For cases occurring in other modes of transport (e.g. buses, trains, etc.), a local risk assessment should be conducted to classify contacts, taking into account the physical environment (e.g. ventilation, crowding) and where the case was seated.*
*** Occupations that are considered at higher risk of infection than the general population due to repeated exposure to cases who may have severe disease and/or likely exposure to large amounts of virus.*
**** Direct physical contact, face-to-face contact within two metres for more than 15 minutes, unprotected contact with infectious secretions or being in the same room for more than 15 minutes.*

Contact tracing is initiated once a case of COVID-19 is confirmed, but in high-risk settings it is recommended to initiate the process upon detection of a probable or possible COVID-19 case.

Having contact with a case at a closer distance and over a longer duration increases the risk of transmission; the 15-minute limit is arbitrarily selected for practical purposes. Repeated shorter encounters over a 24-hour period should also be considered close contact, and public health authorities may classify persons who have had a shorter duration of contact with the case as having had high-risk exposure, based on individual risk assessments.

Other factors that are associated with the risk of infection and should be considered during a risk assessment include:

- if the contact is a household contact,
- if the exposure occurred around the onset of the symptoms in the case,
- if the case was likely to be generating larger amounts of droplets/aerosols (e.g. coughing, singing, shouting, exercising), and
- specific environmental factors that have been associated with increased transmission (e.g. crowding, poor ventilation, indoor exposure).

The classification of contacts into high-risk and low-risk exposure contacts should be based on the level of exposure (Table 1) and on the factors described earlier.

When assessing the risk to the contact person, the vaccination status of the case should not be considered. This is due to the lack of sufficient evidence on the effect of COVID-19 vaccines against onwards transmission. Fully vaccinated individuals infected with the Delta variant may have a viral load that is as high as is seen in infected unvaccinated individuals, although the duration of high viral load may be shorter.

Face masks should be considered as a non-pharmaceutical intervention – in combination with other measures – as part of efforts to limit the transmission of SARS-CoV-2 [47]. The effectiveness of this measure may be lower if face masks are not worn properly at all times. Furthermore, face masks do not protect from transmission through other routes. The use of face masks by the case, the contact, or both could be one factor taken into consideration on a case-by-case basis when determining the contact classification, together with the other factors outlined above (e.g. duration of exposure and the environment where the exposure occurred).

Contact tracing for asymptomatic cases

If a person who tested positive for SARS-CoV-2 reports no symptoms, it is difficult to know when the person started being infectious, which makes it challenging to identify the contacts at risk of exposure. To optimise the identification of contacts at risk of infection, it is recommended that staff carry out interviews with asymptomatic cases to confirm the absence of symptoms and whether there is known exposure to a COVID-19 case.

During the interview, the asymptomatic case can be asked in more depth about possible symptoms [48,49] to determine if they are truly asymptomatic. Some may have developed symptoms since being tested and others may have had mild symptoms that they did not report, as they did not consider them indicative of COVID-19. If symptoms are reported, the case should be treated as a symptomatic case and contacts traced from two days before symptom onset to 10 days after symptom onset.

The asymptomatic case should also be asked whether they have had a known exposure to a COVID-19 case. If so, contacts of the asymptomatic case should be traced starting from two days after the asymptomatic case was exposed to the known COVID-19 case.

If no symptoms or known exposures are identified, it is – from a pragmatic perspective – best to define a contact person of an asymptomatic case as someone who has had contact with the case in the two days before the sample that led to confirmation was taken up to 10 days after the sample was taken. However, given that the asymptomatic case may have been infectious for more than two days before the test result, it is suggested – if resources allow – to ask the case about people they may have exposed for up to a week prior to the test results, in particular in the context of larger gatherings or events where spreading to multiple people may have occurred. This practice may also serve to locate the source of the asymptomatic case's infection (see the 'Source investigation/backward contact tracing' section below).

Key steps after a case is identified

Contact identification

Immediately after a **confirmed case**[i] has been identified, public health authorities can initiate contact tracing by:

- interviewing the case to collect information on clinical history and exposures that may have occurred from two days before symptom onset until the case was isolated;
- tracing the contacts and classifying them into high-risk exposure (close) contacts or low-risk exposure contacts (Table 1);
- ascertaining the vaccination status of the identified contacts and whether they work with vulnerable populations (e.g. providing care to elderly or immunocompromised people) or belong to one of the risk groups for severe COVID-19; and
- communicating with the identified contacts and providing information about suitable infection control measures, symptom monitoring, quarantine and testing.

Contact follow-up

Depending on the exposure risk level and the vaccination status of the contact, public health authorities should consider several follow-up actions (Table 2).

Quarantine refers to remaining at home or in a designated setting for a defined period of time after the last exposure to a COVID-19 case, with the aim of reducing virus transmission.

Isolation refers to the separation of people with symptoms of COVID-19 (or with confirmed infection) from other people for the duration of the infectious period.

Fully vaccinated refers to having completed the recommended number of COVID-19 vaccination doses, with at least 14 days since the final recommended dose.

Unvaccinated refers to all individuals who have not completed the recommended number of COVID-19 vaccination doses (i.e. it also includes those who are partially vaccinated).

[i] In specific high-risk settings, contact tracing may also be initiated after identification of a probable or possible case (see Annex 1 in previous guidance [46]).

Table 2. Key actions for management of vaccinated and unvaccinated contacts[a]

Vaccination status	High-risk exposure contact (close contact)	Low-risk exposure contact
Vaccinated[b]	For a period of 14 days after the last exposure to a COVID-19 case, high-risk contacts should: • Get tested right away ('test on tracing') and self-quarantine at home[c] until informed of a negative test result. – If the test result is **positive**, self-isolate immediately. – If the test result is **negative** (particularly if a RADT was used) consider a second test two to four days afterwards. • Self-monitor daily for COVID-19-compatible symptoms[d]. • Remain contactable by public health authorities. • Respect physical distancing measures (especially with vulnerable people) and use proper hand hygiene and respiratory etiquette (including the wearing of a face mask where recommended). • Self-isolate immediately should symptoms develop and seek medical advice (preferably by phone first) following the recommendations of national/local authorities. • If working with vulnerable people[e], consider following the guidance for unvaccinated high-risk exposure (self-quarantine at home[c] until receipt of a negative RT-PCR test taken on day 10 (preferred) or self-quarantine at home[c] for 14 days).	For a period of 14 days after the last exposure to a COVID-19 case, low-risk contacts should: • Self-monitor daily for COVID-19-compatible symptoms[d]. • Respect physical distancing measures (especially with vulnerable people) and use proper hand hygiene and respiratory etiquette (including the wearing of a face mask where recommended). • Self-isolate immediately should symptoms develop and seek medical advice (preferably by phone first) following the recommendations of national/local authorities. • If working with vulnerable people[e], get tested right away ('test on tracing') and wait for a negative test result before returning to work. – If the test result is **positive**, self-isolate immediately. – If the test result is **negative** (particularly if a RADT was used), consider a second test two to four days afterwards.
Unvaccinated (including partially vaccinated)	For a period of 14 days after the last exposure to a COVID-19 case, high-risk contacts should: • Get tested right away ('test on tracing'). – If the test result is **positive**, self-isolate immediately. – If the test result is **negative**, self-quarantine at home[c] until receipt of a negative RT-PCR test result taken on day 10 (preferred) or self-quarantine at home[c] for 14 days. • Self-monitor daily for COVID-19-compatible symptoms[d]. • Remain contactable by public health authorities. • Use proper hand hygiene and respiratory etiquette (including the wearing of a face mask where recommended). • Self-isolate immediately should symptoms develop and seek medical advice (preferably by phone first) following the recommendations of national/local authorities.	For a period of 14 days after the last exposure to a COVID-19 case, low-risk contacts should: • Get tested right away ('test on tracing') where possible and especially in settings with vulnerable populations or in which transmission is likely. – If the test result is **positive**, self-isolate immediately. • Self-monitor daily for COVID-19-compatible symptoms[d]. • Respect physical distancing measures (especially with vulnerable people) and use proper hand hygiene and respiratory etiquette (including the wearing of a face mask where recommended). • Self-isolate immediately should symptoms develop and seek medical advice (preferably by phone first) following the recommendations of national/local authorities. • If working with vulnerable people[e], get tested right away ('test on tracing') and wait for a negative test result before returning to work. – If the test result is **positive**, self-isolate immediately. – If the test result is **negative** (particularly if a RADT was used), consider a second test two to four days afterwards.

[a] Previously infected individuals should follow the recommendations for fully vaccinated individuals if it has been less than six months from previous diagnosis. If it has been more than six months from previous diagnosis, they should follow the recommendations for unvaccinated (including partially vaccinated) individuals.
[b] The duration of protection is subject to evolving evidence and may need to be taken into account.
[c] See the ECDC technical report Infection prevention and control in the household management of people with suspected or confirmed coronavirus disease (COVID-19) *[50].*
[d] Symptoms of COVID-19 include cough, fever, shortness of breath and sudden onset of anosmia, ageusia or dysgeusia. Additional less specific symptoms may include sore throat, runny nose, nasal obstruction, headache, chills, muscle pain, fatigue, vomiting and/or diarrhoea and confusion, but may also include other symptoms [48,49].
[e] Does not apply to all HCWs working with COVID-19 patients (as described in Table 1). For HCWs, the test on tracing doesn't apply and they should follow the recommendations on regular testing in place.

Wherever possible, unvaccinated high-risk exposure contacts should be actively followed-up by public health authorities and quarantine is recommended [49]. If symptoms of illness occur, contacts should immediately self-isolate and seek medical advice (preferably by phone first), always following the recommendations of national/local authorities.

When contact tracing investigations identify contacts or a potential source in another country, public health authorities should collaborate across borders and exchange data in a secure way (through, for example, the selective exchange messaging function of the Early Warning and Response System (EWRS) of the European Union or share data using the European Digital Passenger Locator Form).

Additional considerations for contact tracing in school settings can be found in the 'Contact tracing in school settings' section below.

Testing and quarantine

The vast majority of the evidence regarding the optimal timing of tests, duration of quarantine and risk associated with early release dates are from the time before the Delta variant was widely circulating [51-58]. There are still considerable uncertainties around several parameters of the Delta variant, such as incubation times, duration of infectiousness and effectiveness of vaccines against infection and transmission. As a result, it is not possible to reliably quantify the residual risk of different testing and quarantine strategies. The recommendations below have been made on the limited evidence available and with operational feasibility in mind. Future evidence on the Delta variant's characteristics and vaccine effectiveness might require an adjustment of the recommended quarantine and testing strategies.

In order to reduce the number of false positive and negative test results, it is essential to use tests with high specificity and sensitivity [59]. A common list of appropriate and mutually recognised rapid antigen detection tests (RADTs) has been published by the European Health Security Committee and is reviewed continuously [60].

Symptomatic contacts – unvaccinated and vaccinated

For contact tracing purposes, all contacts who have symptoms or develop symptoms during follow-up (high-risk and low-risk exposure contacts, unvaccinated or vaccinated) should be tested as soon as possible to allow for case isolation and further contact tracing. All symptomatic contact persons should quarantine while waiting for their results.

Both RT-PCR and RADTs can be considered. If RADTs are used, symptomatic contacts should be tested as soon as possible, but within five days of symptom onset. Negative RADT results should be confirmed with RT-PCR. If there is not enough RT-PCR capacity, the RADT should be repeated within 48 hours.

Those who test positive should immediately self-isolate and be managed as a case. Those who test negative should follow the testing and quarantine guidance as set out in Table 2, which is further described below.

Asymptomatic unvaccinated contacts

It is recommended that unvaccinated contacts without symptoms are tested as soon as possible after being traced ('test on tracing') to enable early identification of any asymptomatic or pre-symptomatic secondary cases among contacts and to start further contact tracing. Both high-risk exposure contacts and low-risk exposure contacts should be tested given the increased transmissibility of the Delta variant. If it is not feasible to test all low-risk unvaccinated contacts, those in settings with vulnerable populations or in which transmission is likely should be prioritised, such as healthcare and social care settings, prisons, certain occupational settings and social events such as choirs or weddings [48]. Special considerations for testing in some settings are outlined in Annex 1 of the previous version of this contact tracing guidance [46].

In most instances, several days have passed by the time the contact person has been reached following exposure to a case. This means that the 'test on tracing' will occur within a few days from exposure to the case and infection will already be detectable in many of the contacts that are infected.

For the test on tracing, RADTs can be used. The burden of initially isolating some false positive cases is compensated by the fact that RADTs offer the fastest alternative to identify and isolate infectious individuals and to start further contact tracing. Negative test results should be confirmed by RT-PCR if it has been more than seven days since exposure to the case. In settings with higher transmission rates, such as long-term care facilities, negative RADTs should always be confirmed with an RT-PCR (or, if RT-PCR capacity is limited, a RADT should be repeated two to four days later). Low-risk exposure contacts do not need to quarantine while awaiting confirmatory testing results.

Unvaccinated high-risk exposure contacts should quarantine until a negative result is received from an RT-PCR test taken on day 10 or, if no test is taken, should quarantine for 14 days. In order to ensure compliance with quarantine or other measures, it is important to communicate that a negative test on tracing does not necessarily mean that they are not infected.

To end quarantine, the preferred option is an RT-PCR test to be taken at day 10 and for the contact to discontinue quarantine upon receiving the negative result. If a test at day 10 is not taken, the contact should remain in quarantine for 14 days after the last exposure to the case. In modelling studies from the pre-Delta

period, testing on day 10 was either equivalent or superior to a 14-day quarantine without a test, as it additionally allows for the identification of asymptomatic cases [51,53-58].

Unvaccinated low-risk exposure contacts should be advised to screen for symptoms, respect physical distancing measures (especially with vulnerable people), use proper hand hygiene and respiratory etiquette (including the wearing of a face mask where recommended) for 14 days after the last exposure.

If the low-risk exposure contact person works with vulnerable individuals, they should not attend work while awaiting the result of the test on tracing. A second test two to four days after the first test could be considered.

Asymptomatic vaccinated contacts

Fully vaccinated high-risk exposure contacts without symptoms should also be tested as soon as possible (test on tracing). There are two purposes of this test:

- to enable early identification of any asymptomatic or pre-symptomatic secondary cases among contacts and to start further contact tracing, and
- to enable vaccinated high-risk exposure contacts that test negative to resume their activities, with some exceptions (see below).

Fully vaccinated high-risk exposure contacts should quarantine until they have received a negative test result from the test on tracing. As fully vaccinated contacts will not be required to quarantine following a negative test result, RT-PCR is the preferred testing option due to its increased sensitivity in detecting infection, but RADTs can also be used. If it has been more than seven days since exposure to the case, RT-PCR should be used.

Even after a negative test on tracing, contacts should be advised to screen for symptoms, respect physical distancing measures (especially with vulnerable people), and use proper hand hygiene and respiratory etiquette (including the wearing of a face mask where recommended) for 14 days after the last exposure to the case.

Public health authorities can also consider retesting vaccinated high-risk exposure contacts two to four days after the test on tracing, in particular if the test on tracing was a RADT. This is to increase the likelihood of identifying and isolating those who are infected, which could be warranted in light of the higher transmissibility of the Delta variant and emerging evidence on lower vaccine effectiveness against the Delta variant and waning immunity [24].

If a vaccinated high-risk exposure contact works with vulnerable populations they should consider not attending work until they get tested at day 10 and have a negative RT-PCR test result. This is an important exception to the overall recommendations for fully vaccinated high-risk contacts described above.

Vaccinated low-risk exposure contacts should be advised to screen for symptoms, respect physical distancing measures (especially with vulnerable people), and use proper hand hygiene and respiratory etiquette (including the wearing of a face mask where recommended) for 14 days after the last exposure. If the contact person works with vulnerable people, they should not attend work while awaiting the result of the first test result. A second test two to four days after the first test could be considered.

The duration of protection following vaccination is subject to evolving evidence. Recommendations for the management of vaccinated contacts may need to be adapted based on evidence that emerges following the publication of this guidance.

Previously infected persons

Balancing the risk with the personal and societal implications, it is suggested that individuals with infection in the last six months are managed in the same way as vaccinated contacts.

Considerations for household contacts

Household contacts are categorised as high-risk exposure contacts. For unvaccinated contacts, the days of quarantine are always counted since last exposure to the infectious case, which poses an extra challenge in the household setting. How the case in the household is managed has implications for the household contacts, as follows:

- If the household case is managed in hospital or is able to be isolated within the home, quarantine duration for the unvaccinated household contact can be counted since the last exposure to the case [50].
- If the household case is managed at home and is not able to isolate from other household members [50]:
  - **The vaccinated household contact** can follow the advice in Table 2. An additional test could be considered at the end of the infectious period of the household case.
  - **The unvaccinated household contact** can quarantine immediately, with the end of quarantine counted from the end of the infectious period of the household case. This would be when both the following criteria for ending isolation are met for the case, according to the latest update of the ECDC guidance [23]: 10 days after symptom onset (or from sample collection, if asymptomatic) and resolution of fever and clinical improvement of other symptoms for at least three days.

However, while cases can be infectious up to 10 days after symptom onset, evidence suggests that transmission after five days of symptom onset is limited [61,62]; however, evidence for the Delta variant is currently not

available. For household contacts, public health authorities could, on a case-by-case basis, make the decision to consider the end of the infectious period as five days after symptom onset in the case.

Severe and immunocompromised cases may shed virus for longer (up to 20 days from symptom onset) and contact with such cases should also be assessed on a case-by-case basis [23].

Contact tracing in school settings

As of 18 October, the majority of children in the EU/EEA below the age of 18 years are unvaccinated (15.3% are vaccinated with at least one dose and 13% are fully vaccinated) [63]. In the context of lifted pandemic restrictions, the continued circulation of the more transmissible Delta variant and the high proportion of susceptible individuals in school-going age groups, the risk of in-school SARS-CoV-2 transmission remains high [64], making in-school prevention measures vital [65].

In-school prevention measures vary largely between schools, regions and countries across the EU/EEA and include combinations of non-pharmaceutical interventions (e.g. physical distancing and/or class cohorting to prevent crowding), as well as safety and hygiene measures, improved ventilation and the use of face masks among education staff and children.

Prolonged and/or repetitive school disruptions have significant negative social, emotional, health and educational impacts on children and their families, as well as broader economic impacts on society [65]. Mitigation and response strategies that avoid or minimise school closures should be given priority where possible [65].

Contact tracing is important in school settings to rapidly identify secondary cases in order to avoid large outbreaks and the interruption of school activities. Contact tracing should be carried out by or in close collaboration with local public health authorities, who may work closely with school authorities to define the most appropriate response based on an assessment of the local situation. In the context of schools, contact tracing should be designed to cause as little disruption as possible to students and staff. Authorities should seek to ensure that decisions are well understood by staff, students and guardians. Contact tracing should be initiated promptly following the identification of a confirmed case and should include contacts in the school (classmates, teachers and other staff), household contacts and contacts from other relevant settings, in accordance with ECDC or national guidance. Contacts should be managed based on their exposure category (see Table 1).

Whereas sharing a classroom can be considered a high-risk exposure, the presence of effective mitigation measures that would lower the risk of some children can be taken into account. Depending on the degree of prevention measures, vaccination and testing being implemented in schools, an optional stepwise approach can be taken in addition to current guidance:

- Test only the closest contacts of a confirmed case.
- If two or more cases (including the index case) in a class are found, test the entire class.
- If additional cases are found in a class, consider quarantining the entire class.

The use of RADT is heterogenous across countries, particularly in the school setting [65]. Where RADTs are available or can be scaled-up, 'test-to-stay' strategies could additionally be considered in an attempt to minimise disruption in school settings and school absenteeism, while also limiting opportunities for further SARS-CoV-2 transmission [66,67]. In a UK open-label cluster-randomised trial, daily testing of school-based contacts was found to be a non-inferior and safe alternative to self-quarantine [67].

Contact tracing in other settings

Guidance for contact tracing in other settings (prison, acute care hospitals, long-term care facilities, aircrafts, cruise ships) can be found in Annex 1 of the previous contact tracing document [46].

Options for enhanced contact tracing

Tracing contacts who had exposure to the case prior to two days before symptom onset

In a preprint study from a well-characterised outbreak in Guangdong Province, using data from 94 transmission pairs, 22.5% of cases (95% confidence interval (CI): 16.0-30.0) started to become infectious four days before illness onset. Infectiousness peaked at 2.1 days (95% CI: 1.5-2.7) before symptom onset [14]. Given the increased transmissibility of the Delta variant, being able to identify, test and quarantine more of the contacts that could be infected may be beneficial in controlling transmission. If resources allow, public health authorities could consider defining contact persons as those who have had an exposure to a case up to four days prior to symptom onset in the case.

Source investigation/backward contact tracing

Traditional 'forward' contact tracing aims to identify individuals that were infected by recent exposure to the case under investigation. In contrast, the objective of 'backward' or 'retrospective' contact tracing is to identify the source of

infection (the 'parent case') of the case under investigation. Backward tracing protocols aim to reduce the transmission by other individuals that were infected by the same parent case. The motivation for backward tracing is that a relatively small proportion of cases is responsible for a large proportion of transmission [68,69]. Additionally, preprint empirical evidence from contact tracing prior to the Delta variant becoming widespread shows that the positivity rate among contacts exposed to a case three to seven days before symptom onset (or test date for asymptomatic cases) was similar to the positivity rate among contacts exposed to a case in the standard contact tracing window [70].

If public health authorities can locate the source case of the current case under investigation, then further contact tracing can be done for contacts of the parent case to stop the chains of transmission resulting from them [71]. During the contact tracing interview, cases can be asked directly where or from whom they think they acquired the infection. Even if the case is not able to identify a place or a person, public health authorities are advised to ask whether they attended any events or gatherings in the one to two weeks prior to symptom onset, especially if these took place in environments known to be at high-risk of transmission [72,73]. Cases should be asked if they can provide contact details of attendees or event organisers, which allows public health authorities to follow up accordingly. It is possible that some places or persons are identified as a potential source of infection by multiple contacts, in which case it is important to prioritise the investigation of places and persons that are identified most frequently [74].

Ways to speed up contact tracing

As it may take several days from symptom onset to testing and the initiation of contact tracing, by the time some contact persons are reached and quarantined, they may already be in the infectious phase and therefore may have already exposed others to infection. This is particularly a concern for the Delta variant due to its increased transmissibility. Public health authorities can enhance and speed up traditional contact tracing operations to address this challenge in the following ways.

Household contacts of contacts

In addition to asking persons with a high-risk exposure to a case to quarantine ('primary contacts'), public health authorities can also consider asking the household members of the contact person ('secondary contacts') to quarantine until the primary contact has received a negative test result from their initial test on tracing [75].

Contact tracing of possible and probable cases

Instead of starting to interview a case only after receipt of a confirmed test result, public health authorities can start interviewing possible or probable cases about contacts while awaiting the test result. This measure is already recommended in certain situations where risk and consequence of transmission may be high (e.g. in long-term care facilities and prisons), but could be considered for regular contact tracing too, if resources allow.

Contact tracing for emerging variants

With the Delta variant dominant in the EU/EEA, contact tracing remains highly important to limit transmission. Other VOCs may emerge in the future and contact tracing may play a key role in preventing a new VOC from becoming established in the community. For this purpose, contact tracing of cases suspected to be infected with VOCs based on laboratory pre-screening [76] or an epidemiological link should be prioritised and efforts made to trace and follow up both high-risk and low-risk exposure contacts in a timely manner and as completely as possible. In addition to the enhanced contact tracing options mentioned previously, the following actions could be considered to mitigate the spread of new variants:

- In order to increase the chance of containing the spread of a new variant, public health authorities should consider releasing high-risk exposure contacts only after a negative RT-PCR test taken on day 14, which can be expected to reduce some of the residual risk remaining with the regular quarantine recommendation [51,56,58].
- To further mitigate the remaining residual risk, in the week after release from quarantine, contacts should also be reminded to strictly observe physical distancing measures at all times, wear a face mask, isolate and immediately report any symptoms that develop.
- To reduce the spread from high-risk contacts who develop asymptomatic infections while in quarantine, household members of quarantined high-risk contacts should be advised to observe strict physical distance measures at all times, wear a face mask outside the home, isolate and immediately report any symptoms that develop.
- If a contact of a case suspected to be infected with a VOC has symptoms when they are identified or if they develop symptoms during follow-up, public health authorities should immediately start contact tracing of their contacts before their test result is confirmed.
- During communication with contacts, the importance of adhering to quarantine should be emphasised, including explaining what is known about the transmissibility of the variant so that they are aware of the public health importance of preventing the variant from becoming established.
- Given that some contacts may already be infectious by the time the test result is obtained and the contacts are traced, public health authorities should consider asking people when they take the test to immediately inform their closest contacts to take extra precautions (e.g. physical distancing or wearing of face masks) while the result is being processed.

Mobile applications

Several EU/EEA countries have adopted digital proximity tracing or mobile applications (apps) in support of contact tracing, which are based on Bluetooth technology in a privacy-preserving manner. The apps can detect the duration and distance of contact between users of the app and, if one later tests positive, the app notifies users who have been in close proximity to the infected user. Digital proximity tracing can complement, but not replace, conventional contact tracing, as not everyone will have the app. It is also important to ensure that contact persons alerted through the app have access to appropriate follow-up by public health authorities. With regard to VOCs, countries are encouraged to monitor the number of notified contacts that are testing positive or measure other proxy indicators in order to understand whether the parameter settings need calibration (e.g. due to a more transmissible variant). Please refer to the ECDC document *Mobile applications in support of contact tracing for COVID-19 - A guidance for EU EEA Member States* for further information and guidance, including further details on evaluating and calibrating settings [77].

ECDC has also, together with WHO, published an indicator framework for the evaluation of the effectiveness of digital proximity tracing [78].

Cross-border contact tracing

Contact tracing of cases or contacts that travel across Member State borders poses a particular challenge. When contact tracing investigations identify contacts or a potential source of infection in another country, public health authorities should collaborate across borders and exchange data in a secure way, for example through the selective exchange messaging function of the Early Warning and Response System (EWRS) of the European Union. The European Digital Passenger Locator Form is another tool that can facilitate this type of collaboration between connected countries. In areas with large-scale, daily international commuting, public health authorities on either side of the border could consider setting up systems for regular collaboration and data sharing related to contact tracing.

Resource considerations

Contact tracing can be resource intensive. Each country will need to adapt their contact tracing intensity to the local epidemiological situation and available resources. ECDC has published a technical report with some options for resource-saving measures, such as the use of well-trained, non-public-health staff; repurposing existing resources such as call centres; reducing the intensity of contact follow-up; and using new technologies such as contact management software and mobile apps. Some countries have employed online tools where cases fill in information about their contact persons directly and only those cases who do not respond receive a phone call. Online tools can also be used to assist with monitoring. To enable scaling up of contact tracing, contacts could also be contacted and informed through text messages instead of phone calls [79].

Prioritising contacts

If resources are very limited, the contacts that have the highest risk of being infected and those that have the highest risk of transmitting to vulnerable populations can be prioritised. These include:

- unvaccinated contacts,
- household contacts and other contacts with prolonged exposure,
- contacts that work with vulnerable populations or who are healthcare workers,
- contacts in specific high-risk settings (e.g. long-term care facilities, prisons etc.), and
- contacts that are part of known clusters.

Additionally, contacts that are at risk of severe disease due to age or comorbidities can also be prioritised to ensure that they know how and when to seek medical attention.

Monitoring and evaluation

Data on contact tracing investigations should be systematically collated and analysed at the local, national and international levels in order to learn from the operation and inform the response. More specifically, the goals of the data collection are:

- to help assess the effectiveness and efficiency of contact tracing operations in order to strengthen and tailor those interventions;
- to provide information on transmission in specific areas, settings and population groups; and
- to provide additional contextual information to help understand the progression of the pandemic and to help tailor response measures such as physical distancing, quarantine and testing on transmission.

Specific contact tracing software such as Go.Data [80] can help follow-up contacts, extract key indicators, visualise chains of transmission, and share data among public health professionals. The user interface is available in many languages, including all EU/EEA languages.

Several indicators that can be used to measure the efficacy and effectiveness of contact tracing operations are included in the ECDC *Monitoring and evaluation framework for COVID-19 response activities in the EU/EEA and the UK* [81]. The following indicators are relevant to local, national and international levels and are, as of October 2021, reportable from European countries through the European Surveillance System (TESSy):

- Proportion of cases where contact tracing is initiated (overall and within 24 hours of diagnosis)
- Proportion of contacts provided with information (overall and within 24 hours from interview with case)
- Proportion of contacts who develop confirmed COVID-19 during the 14 days following last contact with the case
- Proportion of all newly diagnosed cases that had been identified as a contact of a known case in the 14 days prior to diagnosis

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