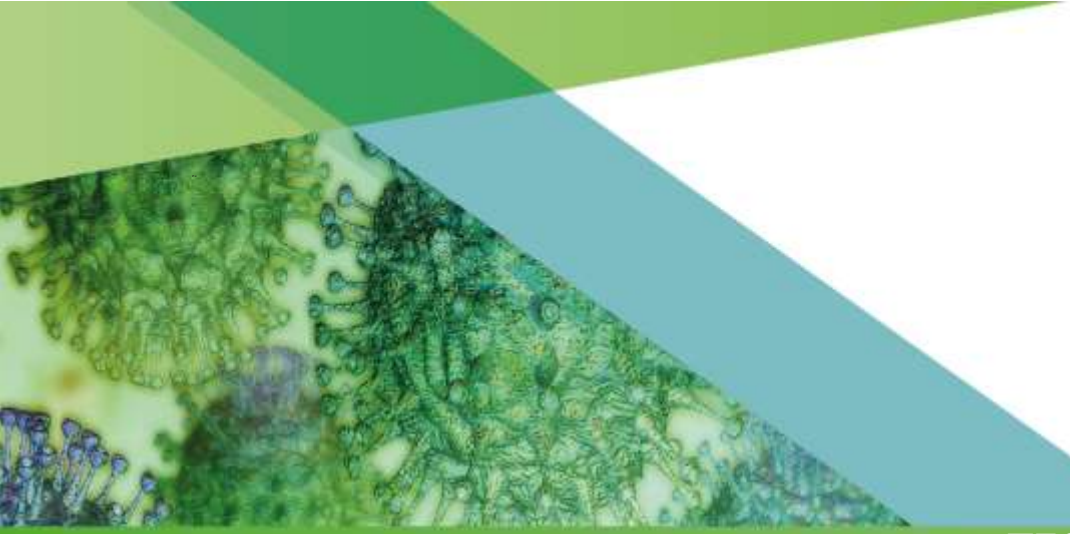

TECHNICAL REPORT

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

18 November 2020

Scope of this document

This document aims to help public health authorities in EU/EEA countries and the UK in their tracing and management of persons, including healthcare workers, 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.

What is new in this document?

- Updates to the definition of contacts;
- Revised recommendations around the testing and quarantining of contacts;
- Options for enhanced contact tracing, including 'backward' or 'retrospective' contact tracing;
- Specific recommendations for key settings, including long-term care facilities and prisons (Annex 1);
- Suggestions for the prioritisation of resources;
- Recommendations for contact tracing using mobile applications;
- Indicators for monitoring and evaluation, and options for the analysis of contact tracing data.

Background

COVID-19 may be transmitted from person to person through several routes [2]. In most instances, coronaviruses are believed to be transmitted from person to person via respiratory droplets, either by being inhaled or deposited on mucosal surfaces, including from aerosols produced when coughing and speaking. Transmission through contact with contaminated fomites is considered possible [3,4]. SARS-CoV-2 has been detected in respiratory and faecal specimens. Viral RNA has also been detected on rare occasions in blood specimens, but there is no evidence of transmission through contact with blood [2,5,6].

The median incubation period of COVID-19 is five to six days, with the majority of symptomatic cases having onset of symptoms between two to 12 days after exposure, and around 95% of individuals displaying symptoms by day 14 [7].

Current evidence indicates that patients with mild-to-moderate COVID-19 symptoms are unlikely to be infectious more than 10 days after symptom onset [8]. A case may already be infectious before the onset of symptoms.

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Virological assessment of the distribution of infectiousness before symptoms start is limited by the paucity of samples from people in the presymptomatic phase [9,10]. The temporal transmission risk distribution - i.e. transmission risk prior to, at and after the onset of symptoms - can be derived from the incubation period and the serial interval in studies of well-defined, infector-infectee pairs. For symptomatic individuals, transmission risk is greatest on the day of symptom onset, with the majority of transmissions occurring from two days prior to the onset of symptoms to two days after [9-14] . A secondary analysis (preprint) of five studies estimates that approximately 10% of transmissions may occur earlier than two days before the onset of symptoms [15]. However, there is a large degree of uncertainty at the tails of these distributions, in part because of limited available data, difficulties in defining the exact time of exposure and true symptom onset, and differences in modelling methodologies applied [9,10].

A recent estimate from a systematic review suggests that the proportion of cases that have asymptomatic infection is around 31% (95% CI 26%–37%) [16]. Asymptomatic transmission, i.e. transmission from an infectious person who has no symptoms throughout the entire course of the infection, is difficult to quantify as most studies are not designed to estimate asymptomatic transmission and estimates are prone to selection bias.

Principles of contact tracing

The purpose of identifying and managing the contacts of COVID-19 cases 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 cases. This is achieved through:

- the prompt identification of contacts of a case of COVID-19;
- 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 symptomatic or not, as soon as possible after they have been identified to allow for further contact tracing;
- testing of low-risk exposure contacts in settings in which transmission is likely and/or the population is vulnerable for severe COVID-19;
- testing all contacts that become symptomatic.

Contact tracing is an essential measure to fight the ongoing epidemic of COVID-19, in conjunction with active case finding and testing, and in synergy with other measures such as physical distancing. Evidence from the response in China and Singapore has indicated that efficient contact tracing helped reduce the time from symptom onset to isolation, and may have substantially reduced the likelihood of ongoing transmission [17,18]. Data collected through contact tracing also contributes to a better understanding of the epidemiology of COVID-19.

The importance of speed

Ensuring that symptomatic individuals are tested as soon as possible after symptom onset is important for the effectiveness of contact tracing and quarantine. To achieve this, the public can be informed of the importance of seeking testing immediately upon appearance of symptoms and testing should also be easily accessible, including for visitors from other countries. Ensuring that tests are processed quickly and contact tracing carried out as soon as possible thereafter is also important for quarantine of contacts to be effective and prevent further transmission. A substantial proportion of transmission from secondary cases can occur before they enter quarantine. It is estimated that halving the time from symptom onset in the index case to tracing of contacts can result in a reduction of more than 50% in the transmission that would otherwise occur before contacts are quarantined [19]. The effectiveness of contact tracing is also highly affected by the extent to which contacts are identified and traced and the degree to which contacts comply with quarantine recommendations [19,20].

When to carry out contact tracing

Each country should adapt their response to the local epidemiological situation and according to available resources. The rigorous and timely application of contact tracing measures during the period when there are only a limited number of cases can play a key role in limiting the future 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 estimated to contribute to reducing transmission in combination with other non-pharmaceutical interventions [21,22]. Contact tracing efforts should always aim to cover cases occurring in specific high-risk settings such as long-term care facilities, prisons and refugee camps, to reduce transmission and mitigate the impact on vulnerable populations [2,23].

ECDC has published a technical report on the resources required for contact tracing, quarantine and monitoring activities, and some of the resource-saving measures are outlined at the end of this document [24].

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 (Table 1) within a timeframe ranging from two days before the onset of symptoms in the case to 10 days[1] after the onset of symptoms [8]. If the case has had no symptoms, further assessment should take place as outlined in the section below on 'Asymptomatic cases'.

The associated risk of infection depends on the level of exposure (Table 1), which determines the type of management. Other factors to take into account when determining exposure risk are detailed in the paragraphs below Table 1 [25-36].

Contact tracing is initiated once a case of COVID-19 is confirmed, but in specific high-risk settings it is recommended to initiate the process upon detection of a probable or possible COVID-19 case (see Annex 1).

Table 1. Classification of contact based on level of exposure

High-risk exposure (close contact)	Low-risk exposure
A person who has had one or more of the following exposures • having had face-to-face contact with a COVID-19 case within two metres for more than a total of 15 minutes over a 24-h period (even if not consecutive); • having had physical contact with a COVID-19 case; • having had direct contact with infectious secretions of a COVID-19 case (e.g. being coughed on); • being in a closed environment (e.g. household, classroom, meeting room, hospital waiting room, etc.) or travelling* with a COVID-19 case for more than 15 minutes; • 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 recommended PPE or with a possible breach of PPE or hand hygiene [2].	A person who has had one or more of the following exposures: • having had face-to-face contact with a COVID-19 case within two metres for less than 15 minutes; • who was in a closed environment or travelling* with a COVID-19 case for less than 15 minutes; • a healthcare worker** or other person providing direct care*** to a COVID-19 case, or laboratory workers** handling specimens from a COVID-19 case, wearing the recommended PPE and having performed appropriate hand hygiene [8].

**See Annex 1 for further details relating to contact tracing for cases travelling on an aircraft or cruise ship. 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 to be at higher risk of infection than 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 meters for more than 15 minutes, unprotected contact with infectious secretions or being in the same room for more than 15 minutes.*

Having contact with a case over 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-h period should also be considered, 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 should be considered during a risk assessment which are associated with increased risk of infection include:

- household contacts;
- if the contact with the case was around the onset of the symptoms in the case;
- if the case was likely to be generating droplets/aerosols (e.g. coughing, singing, shouting, exercising);
- specific environmental factors (crowding, poor ventilation, indoor exposure).

[1] Consider extending to 20 days if the case has severe symptoms or is immunocompromised.

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. From a pragmatic perspective it is 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 which led to confirmation was taken, to 10 days after the sample was taken. However, to optimise the identification of contacts at risk of infection, it is recommended that staff carry out interviews with asymptomatic cases asking some specific questions:

- Ask the asymptomatic case in more detail about a wide range of possible symptoms [37,38] to determine if she/he is 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.
- Ask the asymptomatic case whether she/he has 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.

Face masks

The wearing of face masks by the general public is advised mainly as a means to limit transmission to others, i.e. as source control [39,40]. Experimental studies in animal models [41] and humans [42], observational studies [43,44] and epidemiologic investigations [45,46] indicate that face masks provide partial protection against the transmission of SARS-CoV-2. This effect may be lower when the face mask is not worn properly at all times. Furthermore, face masks do not protect from transmission through other routes. The use of face masks by either the case or the contact, or both, could be one factor that may be taken into consideration on a case by case basis in determining the contact classification, together with other factors outlined above such as duration of exposure and the environment where the exposure occurred.

Persons previously infected

The risk of contact persons who have been previously diagnosed with SARS-CoV-2 infection for subsequent infection and onward transmission is not fully understood and evidence is still emerging. Existing evidence indicates that reinfections with SARS-CoV-2 appear to be fairly uncommon. Reinfections that have occurred have mostly taken place three months or more after the first illness onset [47,48], although there are reports of reinfection as early as 45 days after first infection onset [49-51]. Recent studies have demonstrated more durable serum antibody responses, including after mild or asymptomatic infection, for three to five months following a SARS-CoV-2 infection [52-56]. Correlates of protection are still to be defined, which is necessary to understand the duration of immunity and the possibility of reinfection [57].

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. Balancing the risk with the personal and societal implications, it is suggested that individuals with a high risk re-exposure to COVID-19 within three months of their initial diagnosis can be reclassified as low-risk exposure contacts, unless they work with vulnerable populations or live in a high risk setting such as a long-term care facility or prison. If the new exposure occurs more than three months subsequent to the previous diagnosis, the contact person should be considered at the same risk as any other contact person without previous infection.

Key steps after a case is identified

Contact identification and advice

Immediately after a **confirmed case**[2] has been identified, the next steps regarding contact tracing for public health authorities include:

- Interviewing the case to collect information on clinical history and possible contacts that occurred from two days before symptom onset until the case was isolated. This should be undertaken through a phone call where possible. Cases may be hospitalised and possibly be in a poor condition; in such instances, hospital staff or the treating physician may be able to assist in collecting information either directly from the case or from close family members.
- Tracing the contacts and classifying them into high-risk exposure (close) contacts or low-risk exposure contacts, as described in Table 1 above. Information should also be collected on whether the contact works with vulnerable populations (e.g. providing care to the elderly or to immunocompromised people), or belongs to one of the risk groups for severe COVID-19 themselves.
- Arranging for testing of contacts for SARS-CoV-2.
- Communicating with the identified contacts and providing information about suitable infection control measures, symptom monitoring, quarantine and testing arrangements.

Contact follow-up

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

Wherever possible, high-risk exposure contacts should be actively followed-up by public health authorities, whereas low-risk exposure contacts could self-monitor for symptoms while observing physical distancing measures and avoiding travel. Quarantine is recommended for high-risk exposure contacts [1]. If symptoms of illness occur, contacts should immediately self-isolate and seek medical advice, preferably by phone first, always following recommendations of the national/local authorities.

Quarantine refers to when people exposed to a COVID-19 case remain at home or at a designated setting for a defined period after the last exposure, aiming to reduce 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.

[2] Contact tracing may be initiated in specific high-risk settings after identification of a probable or possible case (see Annex 1)

Table 2. Key actions for management of contacts

Actions	High-risk exposure (close contact)	Low-risk exposure
Individual	For a period of 14 days after the last exposure to a COVID-19 case, high-risk contacts should be advised to: • self-quarantine at home*; • self-monitor daily for COVID-19-compatible symptoms**; • remain contactable by public health authorities; • implement hand hygiene and respiratory etiquette measures (including the wearing of a face mask where recommended); • self-isolate immediately should symptoms develop and seek medical advice, preferably by phone first, following recommendations of the national/local authorities.	For a period of 14 days after the last exposure to a COVID-19 case, low-risk contacts should be advised to: • self-monitor daily for COVID-19-compatible symptoms**; • respect physical distancing measures and avoid travel; • implement hand hygiene and respiratory etiquette measures (including the wearing of a face mask where recommended); • self-isolate immediately should symptoms develop and seek medical advice, preferably by phone first, following recommendations of the national/local authorities.
Public health authorities	• Actively follow-up contacts wherever possible; • Arrange early testing of all contacts (asymptomatic and symptomatic) to diagnose infections and enable any further contact tracing that may be necessary [58]; • Advise contacts to proactively contact public health authorities if they develop any compatible symptoms**; • Arrange timely testing of any contacts who develop COVID-19-compatible symptoms to diagnose infections and enable any further contact tracing that may be necessary.	• Arrange early testing of all symptomatic contacts. Testing should also be arranged for asymptomatic contacts in settings with vulnerable populations or in which transmission is likely, such as health and social care settings, prisons, certain occupational settings and social events such as choirs or weddings [58]; • Advise low-risk contacts to self-isolate proactively and contact public health authorities if they develop COVID-19-compatible symptoms**; • Arrange timely testing of any contacts who develop COVID-19-compatible symptoms to diagnose infections and enable any further contact tracing that may be necessary. • Based on individual risk assessments, public health authorities may consider excluding low-risk exposure contacts from work if they work with vulnerable populations.

** See ECDC technical report on 'Infection prevention and control in the household management of people with suspected or confirmed coronavirus disease (COVID-19)' [59].*

***Symptoms of COVID-19 include cough, fever, shortness of breath, 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, confusion, but may also include other symptoms [37,38].*

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 Early Warning and Response System (EWRS) of the European Union.

Testing of contact persons

Testing for case diagnosis and further contact tracing

All contacts who already have symptoms or develop symptoms during follow-up (high-risk and low-risk exposure contacts) should be tested as soon as possible to allow for case isolation and further contact tracing [58]. Both RT-PCR and rapid antigen tests (RATs) can be considered. With RATs, symptomatic contacts should be tested as soon as possible but within five days of symptom onset. Negative RAT tests should be confirmed with RT-PCR. If there is no PCR capacity, the negative RAT tests should be repeated after two to four days.

It is also recommended that contacts without symptoms are tested as soon as possible after being traced, to enable early identification of any asymptomatic or presymptomatic secondary cases among contacts and to start further contact tracing. This applies to all high-risk exposure contacts and low-risk exposure contacts in settings with vulnerable populations or in which transmission is likely, such as health and social care settings, prisons, certain occupational settings and social events such as choirs or wedding [58]. Both RT-PCR and RATs can be considered. RATs have the advantage of speed which allows for further contact tracing to commence as soon as possible. If more than seven days have passed since the exposure, it is recommended that negative RATs are confirmed by RT-PCR. Special considerations for testing in some settings are outlined Annex 1.

Even if the test is negative, high-risk exposure contacts still need to quarantine, and low-risk exposure contacts still need to observe prevention measures for the remainder of the 14 days after exposure. In order to ensure compliance with quarantine or other measures, it is important to communicate that a negative test at this early stage after exposure does not mean that they are not infected.

Testing to end quarantine early

Testing at the end of quarantine can also be done, in addition to the test taken upon tracing. A negative RT-PCR test at day 10 can be used to discontinue quarantine earlier than the recommended 14 days.

Testing capacity may be limited and it is important that testing contact persons for the purpose of ending quarantine early should not adversely impact test accessibility and test turnaround time for symptomatic people.

Quarantine

ECDC recommends that high-risk exposure contacts remain in quarantine for 14 days after the last exposure to the case. As described above, a negative RT-PCR test at day 10 can be used to discontinue quarantine earlier. However, early release from quarantine needs to be assessed on a case by case basis for contacts working with vulnerable populations or contacts in high-risk settings such as long-term care facilities, prisons, migrant and refugee reception and detention centres. All contact persons released early from quarantine should be advised to be particularly careful until 14 days have passed since exposure, including monitoring of symptoms, limiting social contacts and wearing a mask [60].

Public health authorities should consider measures to help people adhere to quarantine such as income support, help with food and essentials, and to provide facilities for those unable to quarantine at home.

Considerations for household contacts

Contact persons who live in a household where someone has been confirmed as having COVID-19 are high-risk exposure contacts and should quarantine. The days of quarantine are always counted since last exposure to the infectious case, which poses an extra challenge in the household setting.

- If the household case is managed in hospital or is able to be isolated within the home, quarantine for the household contact should be for 14 days following their last exposure to the case (or discontinued after a negative PCR test at day 10). ECDC has published guidance on infection prevention and control measures in the household management of people with suspected or confirmed coronavirus disease [59].
- If the household case is managed at home and is not able to isolate from other household members [59], quarantine for the household contacts should ideally be for 14 days (or earlier if PCR test at day 10 is negative), counted from the day when the household case is not considered infectious anymore. 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:
    - ten days after the onset of symptoms in the case (or from sample collection if asymptomatic);
    - resolution of fever and clinical improvement of other symptoms for at least three days [8].

However, whilst cases can be infectious up to 10 days after symptom onset, evidence suggests that transmission after five days of symptom onset is limited[15,61]. For household contacts, public health authorities could make the decision to count the days of quarantine (14 days, or earlier if PCR test at day 10 is negative) starting from five days after symptom onset in the case. This approach could pose a greater risk for the effective control of onward transmission and should be considered on a case by case basis.

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 [8].

Options for enhanced contact tracing

Backward/retrospective cluster based contact tracing

'Backward' or 'retrospective' contact tracing refers to the process of identifying the source of infection of the case under investigation, to identify further cases and contacts. This contrasts with regular 'forward' contact tracing where contacts who were recently exposed (but also in the past) are identified and quarantined to stop further transmission. The rationale for backward tracing is that a relatively small proportion of cases is responsible for a large proportion of transmission [62,63], often at so called 'super-spreader events'. If public health authorities can locate the source of the infection of the current case under investigation, it is possible that other undetected cases may be found around this original source. Further contact tracing can then be done for these other cases in order to stop the chains of transmission resulting from them [64]. As a secondary benefit, these investigations will also shed light on the circumstances and settings that are relevant to the epidemic spread.

Public health authorities are advised to ask the case under investigation 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 [23,34]. Cases should be asked if they can provide contact details of attendees or event organisers which allows public health authorities to follow up accordingly.

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 have exposed others to infection. Public health authorities can enhance and speed up traditional contact tracing operations to address this challenge in the following ways:

Contact tracing of possible and probable cases

- Instead of starting to interview the case only after receipt of a confirmed test result, public health authorities can start interviewing the case 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. long-term care facilities and prisons (see Annex 1), but could be considered for regular contact tracing too, if resources allow.

Quarantine contacts of contacts ('secondary contacts')

- In addition to just 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 for the same duration [65]. The rationale for this is that the primary contact may, by the time they are reached by contact tracers and asked to quarantine, already be in the infectious phase and have transmitted infection to, for example, household members. By asking those household members to also quarantine, further onward transmission can be prevented.

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 of 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. 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 [66].

Resource considerations

Contact tracing can be resource intensive. Each country will need to adapt their contact tracing intensity to the local epidemiological situation and according to 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 [24].

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:

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

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

Monitoring and evaluation

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' [67]. These indicators are currently not reported to ECDC.

Table 3. Indicators to monitor contact tracing operations

Indicator	Rationale
Use of specialised contact tracing software e.g. Go.Data	Using contact management software facilitates the contact tracing process, coordination and follow-up, in particular in scenarios with large number of daily cases.
Availability of mobile app(s) to complement manual contact tracing and proportion of population that has downloaded them	Mobile apps to support contact tracing could help complement manual contact tracing and it is important to understand population coverage as it is related to effectiveness.
Proportion of cases where contact tracing is initiated (interview with case by public health authorities) within 24 hours of diagnosis	To interrupt transmission contact tracing should be done for as many cases as possible as fast as possible.
Proportion of contact persons reached (contacted and provided with information) within 24 hours from interview with case	To interrupt transmission, as many contacts should be reached as fast as possible with information about quarantine and follow-up.
Proportion of contacts who develop laboratory confirmed COVID19 (at initiation of tracing and over the 14 days follow up period)	The total proportion of contacts who have symptoms of COVID-19 at initiation of tracing and are confirmed to have COVID-19 later is important to understand whether public health authorities need to speed up contact-tracing operations. The total proportion of contacts who develop symptoms during the follow-up period and are confirmed to have COVID-19 later is important to assess whether the definitions used for contact persons are sufficiently sensitive or specific.
Proportion of contacts of COVID19-positive contacts who develop laboratory confirmed COVID19	If a high proportion of second-order contacts develop COVID-19, this indicates that contact tracing operations are too slow and that contacts of confirmed cases are not reached and quarantined soon enough.
Proportion of all newly diagnosed cases that are part of known transmission chains (i.e. who have already been identified as a contact of a known case)	If a high proportion of newly diagnosed cases have previously been identified as contact persons to a confirmed COVID-19 case, this indicates that contact tracing operations have good coverage. A low proportion on the other hand indicates that there is a lot of transmission in the community that is outside the reach of current contact tracing operations. Among the new cases who were known contacts, understanding what proportion were reached by conventional contact tracing, mobile apps or both will help the understanding of the additional contribution of mobile apps to the contact tracing effort, and also if there are any differences in the population reached by either method.
Median number of days from date of onset of COVID-19 symptoms to date of laboratory confirmation of COVID-19	This is an indicator of delays in diagnosis that may be associated with increased transmission and unfavourable outcomes.

Analysis of contact tracing data

Data on contact tracing investigations should be systematically collated and analysed at the local and/or national level in order to learn from investigations and inform the response. Data from contact tracing can provide useful and timely information on the epidemiological situation by providing information on attack rates in specific settings and among certain groups and identifying key settings where transmission takes place.

Data obtained from contact tracing activities can also provide an understanding of the effectiveness of contact tracing as well as the impact of different mitigation measures such as physical distancing, quarantine and testing.

Different online tools exist that can help public health authorities plan contact tracing operations: https://iddynamicsjhu.shinyapps.io/contessa/ [68] and https://www.cdc.gov/coronavirus/2019-ncov/php/contact-tracing/COVIDTracer.html [69]. For the data collection operation itself, specific contact tracing software, such as Go.Data [70], can help follow up contacts, extract the 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.

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Annex 1. Contact tracing in different settings

Setting	Initiation of contact tracing	Classification of contacts	Testing	Quarantine
School **Link to the ECDC guidance**	Contact tracing should begin following identification of a **confirmed case**. Due to the high circulation of influenza that usually occurs amongst children during the flu season, contact tracing should not be undertaken for probable or possible cases.	High-risk exposure (close) contacts: • Students and staff who were in the same classroom at the same time as the confirmed case; • Other students and staff with whom the confirmed case has spent time, according to the criteria in **Table 1** (e.g. students with whom the confirmed case have been in close proximity during breaks or sport activities, in the cafeteria, gym or school playground). • For students and staff in boarding schools/residential schools this may also include those sleeping in the same room or sharing a common kitchen, social space and/or bathroom. Low-risk exposure contacts: • Other students and staff with whom the confirmed case had contact, according to relevant the criteria in Table 1.	As per section 'Contact follow up' above.	As per section 'Contact follow up' above. Children and staff should quarantine and not attend school for 14 days if they live in a household with someone who has been confirmed to have COVID-19.
Prison **Link to the ECDC guidance**	Contact tracing should begin after identification of a **possible/probable cases** without waiting for the laboratory result, to avoid any delays. If the possible case subsequently tests negative contact tracing may be stopped.	High-risk exposure (close) contacts: • Defined according to criteria in Table 1 and may include a person who was in a closed environment (e.g. meeting room, same prison cell, etc.) with a COVID-19 case for more than 15 minutes. It is recommended that an individual risk assessment should be undertaken taking into account the physical environment, e.g. existence of physical barriers between individuals. Low-risk exposure: as per Table 1.	As per section 'Contact follow up' above.	• Group quarantine could be considered where possible for low-risk exposure contacts. • Quarantine should be implemented for a period of 14 days after the last exposure to a COVID-19 case and should continue even if the person in prison is released to the community. • For receptions (new or transferred inmates) to the prison, a system of 'reverse cohorting' could be considered, where single cell accommodation is provided for newcomers to the prison (including those returning from hospital) or grouping new receptions from the same entry date together to prevent the introduction of infection from the community to prison. Reverse cohorting units should quarantine new receptions or transferred inmates for a period of 14 days to detect any cases before allowing them to enter the general prison population.

Setting	Initiation of contact tracing	Classification of contacts	Testing	Quarantine
Acute care hospital **Link to the ECDC guidance**	• Contact tracing should begin after identification of a **confirmed case**.	High-risk exposure (close) contacts: • A healthcare worker or other person providing direct care to a COVID-19 case (direct physical contact, face-to-face contact within two meters for more than 15 minutes, unprotected contact with infectious secretions or being in the same room for more than 15 minutes) or laboratory workers handling specimens from a COVID-19 case, without recommended PPE or with a possible breach of PPE or a breach in hand hygiene [8]. • Other patients who shared a room with the confirmed case or otherwise have been in contact with the confirmed case, according to the criteria in Table 1. • When the confirmed case is a staff member, other staff members with whom the confirmed case has spent time, according to the definition in Table 1 ' (e.g. healthcare workers with whom the confirmed case have been in close proximity in the break room, cafeteria, nursing station, etc.). Low-risk exposure contacts: • A healthcare worker or other person providing direct care to a COVID-19 case, or laboratory workers handling specimens from a COVID-19 case, wearing the recommended PPE and having performed appropriate hand hygiene [8].	All patients and staff who have symptoms compatible with COVID-19 should be tested for SARS-CoV-2. In cases of healthcare-associated transmission, testing of all patients and healthcare workers on the same ward should be considered.	As per section 'Contact follow up' above.
Long-term care facilities **Link to the ECDC guidance**	• Contact tracing should begin after identification of a **confirmed case** amongst residents or staff, and if tracing capacity permits, after identification of a **probable case**.	As per Table 1 and the criteria outlined above for 'acute care hospitals'. Additionally, High-risk exposures: • A 'closed environment' in the context of a long-term care facility may include corridors that are used to access the rooms of both cases and non-cases, particularly those with poor ventilation. Low-risk exposures: • Visitors to non-resident areas for <15 minutes (such as for • deliveries of supplies and collection of refuse)	• Facility staff or residents with symptoms compatible with COVID-19 should be tested for SARS-CoV-2. • Facilities that detect a possible case(s) should consider testing all possible cases as soon as possible, and optimally also performing comprehensive testing of all staff. • Facilities that detect a first confirmed case in a resident or staff member, should test all residents and staff as soon as possible. Negative tests should be repeated within two to three days to detect additional cases that were infected but too early in the incubation period to be detected at the first test. • Further comprehensive testing should be done of all residents and staff weekly/bi-weekly depending on testing capacity. Testing should also be performed on those who have died, if feasible.	Those who have contact with vulnerable persons, or contacts in high-risk settings such as long-term care facilities should quarantine for the full 14 days.

Setting	Initiation of contact tracing	Classification of contacts	Testing	Quarantine
Aircraft [45]	• Contact tracing should begin after identification of a **confirmed case**.	High-risk exposures: • Passengers who were seated in the same section of the aircraft as defined by seat configuration[3], in addition to travel companions or persons providing care, and crew members serving in the section of the aircraft where the index case was seated. • If contact tracing discovers one or more additional COVID-19 case around the index case, then all passengers on the aircraft should be considered high-risk exposure (close) contacts and traced appropriately. Low-risk exposures: • All the other passengers in the aircraft and the other cabin crew. Contact tracing following air travel, requires a case by case approach. Important points for assessment include: • Use of face masks: this measure is recommended in airports and aircrafts since May 2020 [71]. Part of the assessment by contact tracers should include how appropriately were masks used during the different phases of the particular trip, which could play a role in preventing transmission. • Duration of flight: longer flights (usually ≥5hrs) are more of concern due to prolonged stay in the same space, multiple meals are offered and passengers take off masks, need to move, etc. • Whether the index case(s) was symptomatic, particularly coughing (expected creation of more infectious droplets).	As per section 'Contact follow up' above. • In order to allow for early detection of cases and clusters, national/regional/local public health authorities need to ensure that all tourist destinations have easy access or clear operating procedures for the sample collection and testing of any person developing symptoms. Local testing capacity should be developed to ensure timely results. Alternatively, if there is limited or no testing capacity in the area, access to a testing facility and shipment of samples for testing should be planned proactively.	As per section 'Contact follow up' above. • Cross border collaboration and communication among public health and aviation authorities is needed.

[3] Input from civil aviation representatives may be needed to define this on a case-by-case basis. Depending on the configuration it may in fact mean all the passengers in the particular flight.

Setting	Initiation of contact tracing	Classification of contacts	Testing	Quarantine
Cruise ship **Link to the EMSA/ECDC guidance**	• Contact tracing should begin after identification of a **possible, probable, or confirmed case.**	Two different definitions of contacts should be used depending on the number of cases identified on board: • A: If a single possible or probable case OR a couple of possible or probable cases sharing the same cabin have been identified on board, then the following definitions of contacts should be applied: High-risk exposure (close) contact: • A person who has stayed in the same cabin with a case; • A cabin steward who cleaned the cabin of a case or who delivered food to the cabin where the case was staying. • A person who has had face to face contact (on-board or on-shore) within 2 metres for more than 15 minutes or who was in a closed environment for more than 15 minutes with a case. For passengers this could include, but is not limited to, participating in common activities, attending a class, or sharing the same social space such as restaurant or gym. This also includes intimate partners. For crew this may include working in the same area as a case or socialising with a case (including fellow crew members), waiting on a table where a case was dining or leading a social activity where the case was participating. • Healthcare worker or other person providing direct care for a case without wearing appropriate PPE. Low-risk exposure contact: • In a confined space such as a cruise ship where it is difficult to assess the contact exposure, it is advised to consider as low-risk exposure contacts all travellers on board the ship who do not fulfil the criteria for the definition of a close contact. • B: If a single confirmed case OR more than one possible or probable case not sharing the same cabin have been identified: • all travellers on board should be considered as high-risk exposure contacts. This may be modified depending on the risk assessment of individual cases and their contacts, conducted by the public health authorities.	As per section 'Contact follow up' above.	• Contacts of possible and probable cases should be managed as if the case was confirmed until the final test result is available. • High-risk exposure contacts should quarantine. Quarantine should ideally happen in an on-shore facility. If not possible, then contacts should remain in their cabin with the door closed and provided with food and other essentials, while ensuring the safety of crew providing these services. Passengers could also be provided with cleaning materials to clean the cabin, rather than cleaning being done by crew. Cabins where contacts are quarantined should have en suite bathrooms. If two or more people share a cabin and only one of them is a high-risk contact, the contact person should be relocated to a single-occupancy cabin. If two or more people who are identified as contacts share a cabin, and one develops symptoms then they should be managed as a possible case and their contact persons should be subsequently housed in separate cabins. If the cruise comes to an end during the 14-day period, contact persons should be safely disembarked and quarantine continued onshore. • Low-risk exposure contacts should be managed as per **Table 2.** All contacts on a cruise ship should be requested to complete passenger locator forms with their contact details and the locations where they will be staying for the following 14 days.

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