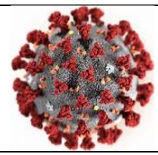
# National COVID-19 Science Task Force (NCS-TF)



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| **Type of document:** Policy Brief | |
| **In response to request from:** Krisenstab | **Date of request:** 20/04/2020 |
| **Expert groups involved:** Digital epidemiology, PH, D&T, ELSI | **Date of response:** 26/04/2020 |
| **Comment on planned updates :** updates planned | |

## SARS-CoV-2 contact tracing strategy: epidemiologic and strategic considerations

**Summary of problem** The Government announced that a staged reduction in social distancing measures to prevent the spread of SARS-CoV-2 would begin on 27th April 2020. The reduction in transmission that has been achieved across Switzerland now needs to be maintained. A strong strategy for testing for SARS-CoV-2, contact tracing of people found to be infected, isolation of infected persons and quarantine of their contacts needs to be implemented to control the spread of infection and avoid a re-imposition of the strictest social distancing measures. Contact tracing activities need to include both classic person-based contact tracing and digital proximity tracing so that the process of identification and quarantine of contacts is quick enough to interrupt transmission. This policy brief summarises: the rationale for contact tracing and for quarantine of contacts; differences between classic person-based contact tracing and digital proximity tracing; the role of virological testing; and social and ethical considerations.

### Executive summary:

- Contact tracing, followed by quarantine, is one of the key non-pharmaceutical interventions to contain the spread of infectious pathogens, including SARS-CoV-2.
- In classic contact tracing, trained personnel interview a SARS-CoV-2 infected person, the index case, identify their contacts over a defined time period, and follow them up.
- Digital proximity tracing is a new approach that notifies people who have been in close proximity to a SARS-CoV-2 index case, using bluetooth-enabled smartphone technology.
- Classic person-based contact tracing and digital proximity tracing are complementary approaches that are both needed as part of a strategy to prevent and control SARS-CoV-2 because SARS-CoV-2 can be transmitted by people before they develop COVID-19 symptoms.
- The contact tracing period for SARS-CoV-2 is from 3 days before the onset of symptoms.
- Contacts should be quarantined for 10 days from the last possible date of exposure with an infected person.
- Contacts could be tested by RT-PCR at the start and end of quarantine if asymptomatic, and if they develop symptoms at any time during quarantine.
- Quarantine protocols (specifically with respect to timing and testing) need to be continually adjusted to newly emerging scientific evidence.

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| ▪ Protection and assistance for people in quarantine need to be assured (including covering costs of testing) in order to achieve strong popular support and high compliance.<br>▪ External accommodation, with medical supervision, needs to be available for contacts who live in a household with vulnerable people, or who cannot maintain quarantine in their own home. |
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| **Unresolved issues**<br>This policy brief will be updated as necessary |

# 1. Introduction

Contact tracing, followed by quarantine, is one of the key non-pharmaceutical interventions to contain the spread of infectious pathogens, including SARS-CoV-2. Contact tracing is one component of the core control strategy of testing, tracing and isolation of detected cases (Salathé M, et al. 2020). Testing finds new cases, who can be isolated. Contact tracing then breaks the onward chain of transmission through quarantine (self-isolation) of the contacts, which allows early detection of those who have become infected before they transmit infection further. Information about new infections identified through contact tracing also helps to identify hotspots of transmission (locations, events, age groups, professions, etc.) which allow targeting of additional interventions for disease control.

Contact tracing typically requires trained personnel, who have knowledge about the infection and about the contact tracing process, and who have good interpersonal skills. The contact tracer needs to interview an infected person (index case) to identify their contacts during the infectious period and then manage each contact appropriately. Each contact might: have already been infected by the index case; be the source who infected the index case; or be exposed but uninfected. This classic contact tracing process requires tailored information systems that allow contact tracers to record essential data about contacts, to monitor them over time and to communicate with other contact tracers across geographical areas securely and confidentially.

The SARS-CoV-2 pandemic has galvanised the development of novel approaches to speed up the identification of contacts. The widespread use of bluetooth-enabled smartphones makes it possible to supplement classic contact tracing with so-called digital proximity tracing (Troncoso C, et al. 2020). Digital proximity tracing uses very different methods from those of person-based classic contact tracing, with different implications for data privacy. Its ultimate goal is to rapidly notify users of possible exposure to an infected person whom they may not know personally. Person-based contact tracing and digital proximity tracing are complementary methods that work together to improve the effectiveness of a contact tracing strategy that contributes to SARS-CoV-2 prevention and control.

## 2. Contact tracing and SARS-CoV-2

The effectiveness of contact tracing and isolation as a strategy to control the spread of an infection depends on both the number of infections that each infected person causes and on how much transmission occurs before the onset of symptoms. Two biological characteristics of SARS-CoV-2 transmission suggest that both classic person-based contact tracing and digital proximity tracing need to be implemented:

1. Droplets of infected respiratory secretions are a major transmission route. According to the World Health Organization (WHO COVID-19 Situation Report 73): "Data from published epidemiology and virologic studies provide evidence that COVID-19 is primarily transmitted from symptomatic people to others who are in close contact through respiratory droplets, by direct contact with infected persons, or by contact with contaminated objects and surfaces."

2. SARS-CoV-2 can be transmitted before the onset of COVID-19 symptoms (pre-symptomatic), or during asymptomatic infection. The estimated proportion of pre-symptomatic transmission varies between 44% and 62% (He X, et al. 2020, Ganyani T, et al. 2020). The infectious period for SARS-CoV-2 begins 1-3 days before the onset of COVID-19 symptoms (He X, et al. 2020; Wei WE, et al. 2020). This characteristic means that contacts of an infected person need to find out as soon as possible if they have been in contact with the infected person so that they can be quarantined. If infected, they will have been identified before transmitting infection to anyone else. Most people with SARS-CoV-2 are expected to develop symptomatic COVID-19, but a proportion will remain asymptomatic throughout their infection. An upper bound of the proportion of asymptomatic infections, based on the early literature is 29% (95% CI 23 to 37%) (Buitrago-Garcia D, et al. 2020); quarantine will reduce transmission by this group too.

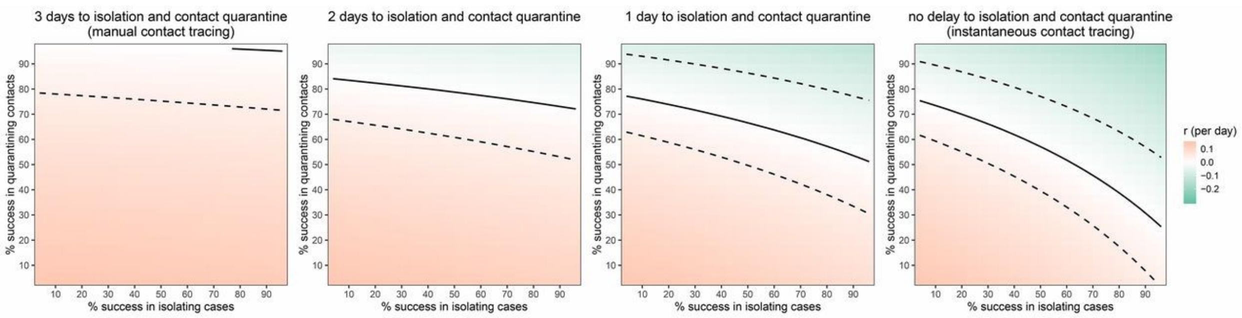


**Figure 1.** Mathematical model output from Ferretti et al. (2020). Panels show decreasing delays in implementation of intervention to isolate cases and quarantine contacts. In this figure, *r* describes the capacity of SARS-CoV-2 to spread - thus *r=0* is equivalent to an effective reproduction number $R_e$ of 1. Plots show "exponential growth rate of the epidemic *r* as a function of the success rate of instant isolation of symptomatic cases (x axis) and the success rate of instant contact tracing (y axis). Positive values of *r* (red) imply a growing epidemic; negative values of *r* (green) imply a declining epidemic, with greater negative values implying faster decline. The solid black line shows *r*=0, i.e., the threshold for epidemic control. The dashed lines show uncertainty in the threshold due to uncertainty in $R_0$."

Together, pre-symptomatic and asymptomatic transmission are estimated to account for 40-60% of all SARS-CoV-2 transmission (Ferretti L, et al. 2020; Ganyani T, et al. 2020; He X, et al. 2020). Therefore, a substantial fraction of the overall transmission is missed if only symptomatic cases are detected and isolated. A combination of prevention and control strategies will continue to be needed, including improved hand- and respiratory hygiene, social distancing, and contact tracing. Ferretti et al. argue, in a mathematical modelling study, that classic contact tracing is not fast enough to prevent SARS-CoV-2 transmission (Figure 1). A digital system will notify people who have been in close proximity with an infected person more quickly than classic contact tracing and allow them to be able to self-isolate, and to get in touch with local health care professionals.

Digital contact tracing uses the bluetooth protocol for proximity tracing. Whilst this protocol was not developed to measure the distance between devices, it does contain information about the signal strength. Ongoing work shows that this information can be used to estimate distance. Overall, if two devices have been in sufficient proximity, for a sufficient amount of time, one should be able to conclude that droplet transmission from an infected to a susceptible person could have occurred. The DP3T (decentralized privacy-preserving proximity tracing) consortium is developing a digital contact tracing system in full transparency, led by EPFL and ETHZ, that allows close proximity contacts of an infected person to be notified in a decentralized, highly privacy-preserving way (Troncoso C, et al. 2020). The Swiss national advisory commission on biomedical ethics has concluded that no fundamental ethical principles oppose digital proximity tracing, but that strict conditions need to be applied (Swiss Advisory Commission on Biomedical Ethics, 2020).

**Table 1.** Comparison of the characteristics of classic person-based and digital proximity tracing

| **Characteristic** | **Person-based contact tracing** | **Digital proximity tracing** |
|---|---|---|
| Identification of contacts | Based on interview of index case. Limited to the individuals that index case can recall and can get in touch with. Not limited to proximity only. | Based on physical proximity of a contact to the index case for a defined time period. Does not require individual recall. Requires the index case and contacts to use the app. |
| Contact routes | Can identify individuals that have been infected through droplets, direct contacts, but also contaminated objects. | Identifies only individuals based on proximity and thus not transmission via contaminated objects. |
| Speed of identifying contacts | Depends on number of contact tracers to interview the index | Immediate alert of contact if index case triggers system. |

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| | case and then to reach contacts.<br>Not instantaneous. |

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| Characteristic | Person-based contact tracing | Digital proximity tracing |
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| Personnel requirements | Contact tracing, follow-up and counselling require intensive human labour. Computer software can reduce workload of recording and tracking contacts | Contact identification requires no human input. The follow-up process and counselling are the same as for classic contact tracing. |
| Identification of people with asymptomatic or pre-symptomatic infection | When combined with RT-PCR testing of contacts, classic contact tracing may identify infected people without symptoms at the time of testing. | When combined with RT-PCR testing of contacts, digital contact tracing may identify infected people without symptoms more quickly than classic contact tracing. |
| Monitoring of quarantine | Contact tracers can communicate with contacts, ask about symptoms, provide support and assess individual circumstances. | Digital proximity tracing does not allow ongoing monitoring after the contact has been alerted |
| Insights into infection transmission | Contact tracing allows linkage between cases, and generates insights into infection hotspots/clusters and affected age groups or professions. Allows identification of cases with no known links, which is an indicator of poor control. | The DP-3T model does not allow linkage between case and contact to protect privacy, so hotspots of transmission cannot be identified digitally. |
| Experience with the approach | Classic contact tracing is a long-established method for infection control worldwide. | Digital proximity tracing through proximity tracking is new. Countries such as South Korea and Singapore have the most experience. |
| Acceptability and coverage | Classic contact tracing will identify contacts, assuming enough contact tracers. independent of any prior enrollment | Contacts will be identified if they decided to use the app. Overall acceptance and participation are key to the success of this approach |

Abbreviations: RT-PCR, reverse transcriptase PCR

## 3. What happens to the contacts of an index case with SARS-CoV-2?

If found to be infected, a contact becomes a new index case, who needs to be isolated and for whom the contact tracing process begins again. All other contacts should go into quarantine (self-isolation) to prevent onward transmission of SARS-CoV-2. The next section describes the rationale and practical aspects of quarantine for contacts identified through either classic contact tracing or digital proximity tracing.

### 3.1 Who needs to go into quarantine?

Quarantine is the separation of people potentially exposed to an infectious agent during the incubation period. For infections like SARS-CoV-2, which can be transmitted before symptoms develop, effective quarantine ensures that people who have become infected do not transmit infection when they are most infectious - even without symptoms - and thus prevents further spread. A study of 77 infector-infectee transmission pairs with SARS-CoV-2 in China (He X, et al. 2020) concluded that "more inclusive criteria for contact tracing to capture potential transmission events 2 to 3 days before symptom onset should be urgently considered for effective control of the outbreak."

Quarantine to prevent SARS-CoV-2 transmission has to be considered for all potential contacts, not just those with symptoms and irrespective of a negative RT-PCR test after exposure to an infected person. A negative test at time point *t* cannot exclude that a person will become contagious at time point *t+1*. It simply means that the viral load in the potentially infected person has not yet reached sufficiently high levels to be detected by RT-PCR tests at time *t*.

The definition of a potential contact should follow standard protocols. The European Centre for Disease Prevention and Control (ECDC Technical Report, 2020) has clear definitions of high-risk contacts:

- A person having had face-to-face contact with a COVID-19 case within two meters for more than 15 minutes;
- A person having had physical contact with a COVID-19 case;
- having unprotected direct contact with infectious secretions of a COVID-19 case (e.g. being coughed on);
- A person who was in a closed environment (e.g. household, classroom, meeting room, hospital waiting room, etc.) with a COVID-19 case for more than 15 minutes;
- A person in an aircraft, sitting within two seats (in any direction) of the COVID-19 case, travel companions or persons providing care, and crew members serving in the section of the aircraft where the index case was seated (if severity of symptoms or movement of the case indicate more extensive exposure, passengers seated in the entire section or all passengers on the aircraft may be considered close contacts);
- A healthcare worker or other person providing care to a COVID-19 case, or laboratory workers handling specimens from a COVID-19 case, without recommended personal protective equipment (PPE) or with a possible breach of PPE.

Classic contact tracing can, in principle, identify individuals in any of the above listed categories, but is limited to those contacts that the primary case can recall. Contact tracers use their skills to assess the level of risk for an individual contact. Of note, ECDC specifies that “public health authorities may consider some persons who had a shorter duration of contact with the case as having had high-risk exposure, based on individual risk assessments.”

The digital contact tracing system to be used in Switzerland, based on DP3T, cannot link contact networks because of its decentralized privacy-preserving nature. It can simply detect, with reasonable accuracy, that two devices were in proximity of two meters for at least 15 minutes. It also cannot determine whether interactions within a radius of two meters involved face-to-face contact, presenting a higher risk of transmission than face-to-back or back-to-back contact, as it is based on proximity and duration of contact only.

## 3.2 How long does quarantine last?

Quarantine needs to be long enough to cover the period during which people who have become infected with SARS-CoV-2 will develop symptoms or have infection detectable by RT-PCR (at which point their quarantine effectively changes into case isolation). The incubation period of SARS-CoV-2 (the time from infection to development of symptoms) is generally accepted to be up to 14 days (WHO COVID-19 Situation Report 73). Longer incubation periods have been reported, but are rare. The temporal distribution of the incubation period is estimated to have a median of around 5 days (Figure 2).

A quarantine duration of 10 days from the time of the last possible exposure can be justified, given that Lauer et al. report the 97.5% percentile for time until symptom development at 11.5 days (95% CI 8.2 - 15.6) (Lauer SA, et al. 2020).

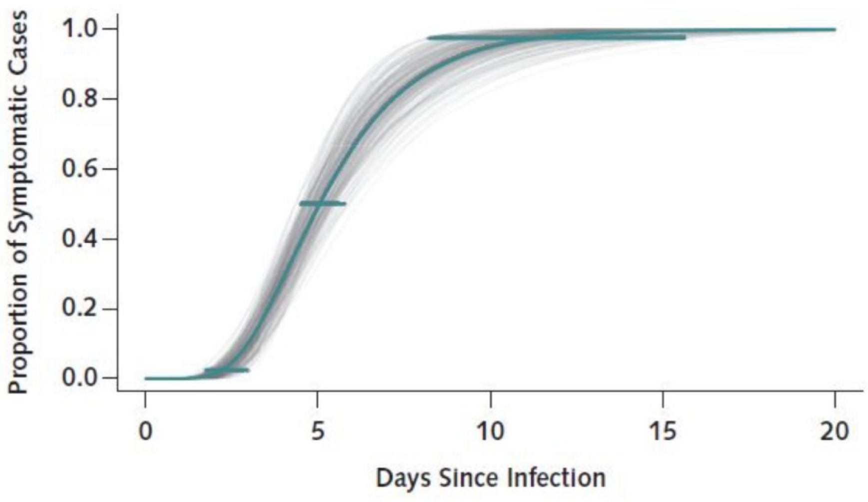


**Figure 2.** Incubation period distribution. Symptom onset will occur within 11.5 days (CI, 8.2 to 15.6 days) for 97.5% of infected persons. From Lauer SA, et al. 2020.

## 3.3 What is the role of testing of index cases and contacts?

Contact tracing is triggered by the diagnosis of a SARS-CoV-2 positive case, typically by an RT-PCR test on a nasopharyngeal swab, or other specimen type. The contact tracing process could be either classic or digital (or both).

RT-PCR testing should not be used to decide whether contacts should be initially quarantined. A negative RT-PCR test cannot exclude SARS-CoV-2 infection soon after exposure to a person with confirmed infection, because the viral load might not be high enough to be detected by RT-PCR. RT-PCR testing of contacts has an important role, however. In South Korea, for example, testing of contacts is a part of its COVID-19 containment strategy (personal communication from South Korean CDC).

A proposed schedule for RT-PCR testing of contacts is:

- At the time of identification as a contact at the start of quarantine;
- At any time during quarantine if symptoms of COVID-19 develop;
- At the end of quarantine, if still asymptomatic.

For the reasons outlined above, testing cannot at the moment provide early quarantine release signals. In any case, quarantine protocols should be regularly adjusted to emerging scientific evidence as well as to the developments of new tests. In particular, early quarantine release protocols should be continually evaluated, but must not jeopardize the epidemiological goals of contact tracing and quarantine. RT-PCR testing also has potential uses for research about SARS-CoV-2 transmission, and will provide epidemiologically important information.

Serological tests are currently of limited use in a contact tracing system for two reasons. First, serological tests do not detect SARS-CoV-2 infection as soon as RT-PCR. Second, at this stage, a positive serological test (i.e. detection of virus-specific IgG in the blood) might indicate prior infection, but it cannot be considered as a guarantee of immunity against reinfection. This latter point may change due to new scientific evidence, including long-term epidemiological follow up of COVID-19 patients. Only then could some individuals be considered as not requiring quarantine, given their existing immunity will prevent them from getting and transmitting the virus.

## 3.4 Social and ethical issues for people in quarantine

People who need to go into quarantine need to have adequate protection and assistance, including testing that is completely free of charge. Legal protection must exist against job loss for the duration of quarantine; social protection must exist against loss of income for the same period. For quarantined persons who live with others, personal protective equipment should be provided to their families. For those who live with persons who are particularly vulnerable to COVID-19, an alternative to home quarantine should be provided. Since quarantine requires the assistance of at least one person, the legal and social protections required for quarantined persons should also be extended to their informal caregivers. These considerations are important from an epidemiological perspective: If quarantine is perceived as having negative personal consequences, compliance and support will be low, and the effects of contact tracing and quarantine will be minimal.

## 4. Has Switzerland the means to conduct an intensive contact tracing strategy?

Switzerland should be in a position to conduct intensive contract tracing for SARS-CoV-2 now using both classic person-based contact tracing and digital proximity tracing. A sussessful introduction of contact tacing and integration of DP3T will need both strong awareness in the Swiss population and high uptake and use of the app (Forster N, et al. 2020). As Switzerland has encouraged strict social distancing measures since early March, the number of high-risk contacts should have reduced substantially, resulting in reduced transmission with around 200 to 250 new confirmed cases per day across the country from mid-April 2020, and $R_e$, the effective reproduction number, is below one. In the light of the announced staged release of the lockdown measures, any recommended contact tracing strategy will crucially depend on the available resources to execute such as strategy. The capacity for contact tracing for SARS-CoV-2 differs between countries in which contact tracing is a core part of the control strategy. The reported or suggested number of contact tracers per 100,000 population is 4 in New Zealand, 7 in Iceland, 15 in Massachusetts, 81 in Wuhan (Johns Hopkins Center for Health Security Report, 2020).

During the transition phase, the lower numbers of new cases and contacts now provide an opportunity to build capacity and civil society support for intensive contact tracing using both classic person-based contact tracing and digital proximity tracing (Forster N, et al. 2020). To estimate requirements for RT-PCR tests, we provide an example. We assume that the more liberal testing guidelines might result in 500 newly diagnosed cases per day. If each newly diagnosed SARS-CoV-2 index case had an average of 10 high-risk contacts in the 3 days before onset of symptoms and each contact is tested twice, 10,000 tests per day would be required for the contacts only. This is well within current testing capacity (C. Metzger, Spiez lab and NCS-TF Diagnostics and Testing Expert Group, communicated to FOPH April 21, 2020), even with other needs (e.g. routine screening in the health care sector). As a comparison, the testing capacity of South Korea is approximately 25,000 tests per day (personal communication from South Korean CDC).

## 5. References

Buitrago-Garcia D, Counotte M, Egli-Gany D, Hossmann S, Imeri H, Salanti G, Low N. The role of asymptomatic SARS-CoV-2 infections: rapid living systematic review and meta-analysis. National COVID-19 Task Force Working Paper. Available from: https://ncs-tf.sp.ethz.ch/_layouts/15/WopiFrame.aspx?sourcedoc={9380D12F-A33D-43CC-9F95-99D0ACFBCF67}&file=Rapid_review_asymptomatic_taskforce_v2_200420.pdf&action=default

ECDC Technical Report. Public health management of persons, including healthcare workers, having had contact with COVID-19 cases in the European Union – second update, April 2,

2020. Stockholm; European Centre for Disease Prevention and Control. Available from: https://www.ecdc.europa.eu/en/covid-19-contact-tracing-public-health-management

Ferretti L, Wymant C, Kendall M, Zhao L, Nurtay A, Abeler-Dörner L, Parker M, Bonsall D, Fraser C. Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. Science 2020 10.1126/science.abb6936. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32234805

Forster N, de Boer E-M, Paeffgen N, Wagner C, Kopp C. Corona-App & Quarantäne: Kommunikation, Verhaltswissenschaften und Zivilgesellschafts-Allianz. NCS-TF Expert Group on Digital Epidemiology Ad hoc Working Group: COVID Contact Tracing & Quarantine Working Paper, April 28, 2020.

Ganyani T, Kremer C, Chen D, Torneri A, Faes C, Wallinga J, Hens N. Estimating the generation interval for COVID-19 based on symptom onset data. medRxiv 2020 doi: 10.1101/2020.03.05.20031815. Available from: https://www.medrxiv.org/content/medrxiv/early/2020/03/08/2020.03.05.20031815.full.pdf

He X, Lau EHY, Wu P, Deng X, Wang J, Hao X, Lau YC,Wong JY, Guan Y, Tan X, Mo X, Chen Y, Liao B, Chen W, Hu F, Zhang Q, Zhong M, Wu Y, Zhao L, Zhang F, Cowling BJ, Li F, Leung GM. Temporal dynamics in viral shedding and transmissibility of COVID-19. Nat Med 2020. Available from: https://www.nature.com/articles/s41591-020-0869-5.pdf

Johns Hopkins Center for Health Security: A National Plan to Enable Comprehensive COVID-19 Case Finding and Contact Tracing in the US. April 2020. Available from: https://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2020/200410-national-plan-to-contact-tracing.pdf

Lauer SA, Grantz KH, Bi Q, Jones FK, Zheng Q, Meredith HR, Azman AS, Reich NG, Lessler J. The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application. Ann Intern Med. 2020; [Epub ahead of print 10 March 2020]. doi: https://doi.org/10.7326/M20-0504

Salathé M, et al. COVID-19 epidemic in Switzerland: on the importance of testing, contact tracing and isolation. Swiss Med Wkly 2020;150:w20225. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32191813

Swiss Advisory Commission on Biomedical Ethics. Contact Tracing as Instrument for Pandemic Control. Position Paper number 33/2020. April 6, 2020: Bern; National Ethics Commission. Available from: https://www.nek-cne.admin.ch/inhalte/Themen/Stellungnahmen/NEK-stellungnahme-Contact_Tracing.pdf

Troncoso C, et al. Decentralized Privacy-Preserving Proximity Tracing. (2020). https://github.com/DP-3T/documents/blob/master/DP3T%20White%20Paper.pdf

Wei WE, Li Z, Chiew CJ, Yong SE, Toh MP, Lee VJ. Presymptomatic Transmission of SARS-CoV-2 — Singapore, January 23–March 16, 2020. MMWR Morb Mortal Wkly Rep 2020;69:411–415. Available from: http://dx.doi.org/10.15585/mmwr.mm6914e1

WHO COVID-19 Situation Report 73. April 2, 2020: Geneva; World Health Organization. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200402-sitrep-73-covid-19.pdf?sfvrsn=5ae25bc7_2