COVID-19 – What We Know So Far About...  
Asymptomatic Infection and Asymptomatic Transmission

Introduction

“What We Know So Far” documents are intended to provide an overview of some of the published and unpublished reports related to emerging issues with respect to coronavirus disease 2019 (COVID-19). The reports are found through ongoing scanning of the published literature and scientific grey literature (e.g., ProMed, CIDRAP, Johns Hopkins Situation Reports), as well as media reports. It is recognized that there may be additional information not captured in this document. As this is a rapidly evolving outbreak, the information will only be current as of the date the document was written.

Key Points

This document summarizes the evidence regarding asymptomatic infection and transmission of SARS-CoV-2, the virus that causes COVID-19, by individuals who are asymptomatic. For clarity, in this document we will use the term COVID-19 to refer to both the virus and the disease.

Asymptomatic infection:

- There is clear evidence of asymptomatic infection with COVID-19. Estimates of the proportion of laboratory-confirmed cases who are asymptomatic may vary by age group, study setting and study methodology ranging from 1.2% (China), 6.4% (Italy), 12.9% (pediatric cases in China), 13.0% (long-term care facility in Washington State), and 17.9% (modelled estimate based on data from the Diamond Princess cruise ship). The extent to which screening is undertaken in group exposures and for contacts of cases, as well the duration of follow-up to ensure asymptomatic individuals do not subsequently develop symptoms will also influence the proportion of cases who are asymptomatic.

Asymptomatic transmission:

- There is some limited evidence of transmission from people who are asymptomatic and never develop symptoms, and more evidence of transmission from people who are in their incubation period (i.e. people who transmit infection while asymptomatic, but prior to their development of symptoms). Several case reports from China have suggested transmission occurring as early as five days before symptom onset, although it is possible that there was another unrecognized source of infection, instead of the individual who was described as the source case in these reports. Other studies have estimated the serial interval (time from onset
Background

Asymptomatic infection occurs when an individual is infected but experiences no symptoms, while asymptomatic transmission occurs when an individual without symptoms transmits the virus to another person. There are two mechanisms by which asymptomatic transmission can potentially occur:

1. Transmission from an individual who never develops symptoms - if the infected person is asymptomatic throughout their infection, but nevertheless is infectious.
2. Transmission during the incubation period - if the infected person is infectious before they develop symptoms.

Asymptomatic infection

A number of case reports describe asymptomatic COVID-19 infection Hoehl S et al., Tong ZD et al., Bai Y et al., Hu Z et al., Zou L et al., including among children (Wei M et al., Chan JF et al., Kam K et al., Hu Z et al.,) and in a pregnant woman (Liu Y et al.). Notably, a few studies have demonstrated the following:

- Asymptomatically infected individuals can have abnormal chest imaging. Hu Z et al. showed that 12 of 19 asymptomatic adults and children had abnormal chest CT scans and Chan JF et al. described an abnormal chest CT in a 10-year old asymptomatic child.

- Some studies have reported high viral loads in asymptomatic individuals as measured by real-time reverse transcriptase polymerase chain reaction (RT-PCR). Zou L et al. noted that an asymptomatic individual had similar viral loads from nasal and throat swabs compared to 17 symptomatic individuals. Kam K et al. noted a high viral load in a nasopharyngeal specimen in a generally well baby. Nasopharyngeal specimens were positive for 16 days and one stool specimen was also positive.

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The extent to which screening is undertaken in group exposures and for contacts of cases, as well the duration of follow-up to ensure asymptomatic individuals do not subsequently develop symptoms will also influence the proportion of cases who are asymptomatic. Future serologic studies will provide a clearer picture of the extent of asymptomatic infection.
Asymptomatic infection based on surveillance system data

- A report from the Chinese Center for Disease Control and Prevention (China CDC) on 72,314 patients as of February 11, 2020 indicated that 889 (1.2%) were asymptomatic (i.e., tested positive on viral nucleic acid tests but did not show symptoms).

- Using the same data source and many of the same cases as the China CDC report above, a study by Dong et al. focusing on pediatric cases indicated that of 731 laboratory-confirmed children, 94 (12.9%) were asymptomatic (i.e., tested positive on viral nucleic acid test but did not show symptoms) and had normal chest imaging. The proportion of confirmed cases who were asymptomatic ranged from 8.1% in children <1 year of age to 17.5% for those 6-10 years of age.

- The integrated surveillance report from Italy indicated that by March 26, 2020 there were 73,780 COVID-19 cases. Of the 22,013 cases with clinical data available, 6.4% were categorized as asymptomatic and 12.1% as paucisymptomatic (not further defined). The context for testing those who are asymptomatic is not specified.

Asymptomatic infection from screening potentially exposed individuals

- Mizumoto K et al. reported on asymptomatic COVID-19 infections among those tested as part of the outbreak on the Diamond Princess cruise ship (3,711 passengers and crew). A total of 3,063 tests were done and 634 people tested positive. Of these, 328 (51.7%) were asymptomatic at the time of testing. It is difficult to evaluate this proportion, as it is possible that individuals developed symptoms after testing. Adjusting for the possible future development of symptoms (right censoring) using a statistical model, Mizumoto et al. estimated the asymptomatic proportion to be 17.9% (95% credible interval (CrI): 15.5 to 20.2%).

- Kimball A et al. reported on infections in a long-term care home in Washington State, United States where, as part of outbreak management, 76/82 (93%) of residents underwent laboratory testing for case finding. Of these, 23 residents were positive, of which 13 (57%) were asymptomatic at the time of laboratory testing. Further assessment of this group one week after testing revealed that 10/13 had developed symptoms, bringing the asymptomatic proportion to 3/23 (13.0%).

Asymptomatic transmission

Several case reports describe transmission from people with COVID-19 infection who never developed symptoms, and others describe transmission from individuals during their incubation period (i.e. prior to the development of symptoms).
Transmission from people who never developed symptoms

- A study by Bai Y et al. reported on an asymptomatic individual who transmitted COVID-19 to five family members. She tested positive 18 days after her presumed exposure, with a negative test on day 16 and two negative tests on days 26 and 29. Although the authors argue that the asymptomatic individual was the source of infection for the family members, the family visited a hospital as well. Although the hospital reported no COVID-19 cases at that time, this is a potential alternative source of exposure.

- Hu Z et al. reported on an asymptomatic case who appears to have acquired his infection in Hubei province and transmitted his infection to his wife, son and daughter-in-law who lived with him in Nanjing. His family members denied any other known exposures to confirmed or suspect COVID-19 patients.

Transmission during the incubation period

Several studies describe potential transmission in the incubation period or in the early symptomatic period. In most instances, the contacts who acquired the infection reported no other known sources of exposure other than a case who was in their incubation or early symptomatic period.

- Rothe C et al. was the first study published that described potential transmission during the incubation period. This was a case report of an individual from China (source case) who attended three days of meetings in Germany with business partners and was initially thought to be asymptomatic until the day she flew home. She then tested positive for COVID-19 upon returning to China, following which it was discovered that some of her German colleagues were infected too. Upon further investigation, additional information from the source case indicated that she had experienced some mild non-specific symptoms while in Germany. Although the first German case was infected by the source case, another two German cases did not have exposure to the source case and may have been infected by the first German case. Of these two cases, one had their last exposure to the first German case one day after the first case’s exposure to the individual from China and three days before the first German case’s onset of symptoms. This study suggests that transmission may have occurred one day after exposure and three days before symptom onset. It also demonstrates transmission with early and non-specific symptoms.

- Several other studies describing infections in China suggest transmission during the incubation period. It should be noted that due to circulation of COVID-19 in China during this time, it is possible that there was another unrecognized source of infection, in addition to the cases reported.

- Yu P et al. described an 88-year-old man from Shanghai who developed symptoms five days after the arrival of two visitors from Wuhan. The two visitors developed symptoms after the man, with the earliest symptom onset among the two visitors occurring 11 hours after the man’s first symptoms. This suggests that at least one of the visitors had spread infection in their incubation period. Assuming the visitor with the earliest symptom onset transmitted infection to the man, the earliest the infection could have occurred is from five days before onset of illness in that visitor, based on the date of the visitors’ arrival. The latest the infection could have occurred is dependent on the incubation period in the
man. Assuming a very short incubation period of only one day, the visitor would have been infectious just over one day before symptom onset.

- **Huang R et al.** described a patient from near Wuhan who visited her family in Nanjing and did not develop symptoms until four days after leaving Nanjing. She infected six family members, some of whom she lived with and some with whom she attended one or more dinners with, including one on the day before her departure. Two family members, who appear to have been infected at the family dinner with the visiting woman the day before her departure, attended another family dinner with three different relatives. This occurred on the day after the dinner with the visiting woman, and three and four days before the onset of symptoms. The three relatives subsequently developed symptoms and were found to be infected with COVID-19. **This suggests that transmission can occur at least five days before symptom onset and that transmission may occur as early as one day following exposure.**

- **Tong ZD et al.** reported a case of COVID-19 from Wuhan who attended a conference in Zhoushan three days before illness onset. Two colleagues from Zhoushan also attended the conference and dined with the case the following day (two days before illness onset), sharing the same serving plates. The two colleagues were subsequently confirmed to be infected. **This suggests that the source patient likely infected his two colleagues at least two days prior to symptom onset.**

### Studies comparing the incubation period and the serial interval

The serial interval is the time from onset of symptoms in one case to the time of symptom onset in the case(s) they infect. When the serial interval is shorter than the incubation period, some transmission is likely to have occurred in the incubation period. Some studies (for example, Nishiura H et al. and Du Z et al.) found a short serial interval ranging from a mean of 3.96 days to a median of 4.6 days. This is shorter than the mean incubation period of five days referenced by Nishiura et al., suggesting transmission during the incubation period.

### References


Citation
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