

Transmission routes for SARS-CoV-2 infection: review of evidence

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Abstract

There is no specific treatment for SARS-CoV-2, and all infection control strategies are based on breaking the transmission chain of virus. The high transmission rate of SARS-CoV-2 has raised many questions about the possible routes of infection transmission. Due to uncertainty of the main transmission routes, the infection control policies faced with more challenges. The possible main route of transmission is thought to be the close contact and respiratory droplets. Therefore, it is necessary to maintain physical distance and using the face mask. Another routes of transmission are through contaminated surfaces as well as airborne, fecal-oral transmission.

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To the Editor,

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is still at the forefront of the world's news. There is no vaccine and no drug for the virus, and all infection control strategies are based on breaking the transmission chain of the virus. The ability of the coronavirus family to cross the species barrier was further established when the emerging SARS-CoV-2 was identified (after the identification of the SARS

coronavirus in 2003 and Middle East respiratory syndrome (MERS) coronavirus in 2012). SARS-CoV-2 was transmitted from animals to humans, and then between humans at high speed. Now, months after the start of the pandemic, the number of cases is increasing daily. The high transmission rate of SARS-CoV-2 has raised many questions about the possible routes of infection transmission. In the early days of the epidemic, it was thought that transmission was occurring only from symptomatic individuals, but as the story progressed, it became clear that transmission from pre-symptomatic and asymptomatic individuals was possible [1,2]. The uncertainty surrounding the main transmission routes has meant that infection control policies are faced with more challenges.

The possible main route of transmission is thought to be close contact and respiratory droplets secreted by the patient during coughing, sneezing, breathing and even normal speech. Therefore, it is necessary to maintain physical distance and to use a face mask. Another route of transmission is through contaminated objects or fomites. Touching the T-zone of the face, after contact with these objects, is also a means of transmission, which emphasizes the need for hand hygiene and hand washing.

Subsequent studies have shown that the virus is also present in saliva; given the evidence of virus transmission from asymptomatic individuals [1] and the presence of the virus in saliva, it has been suggested that even secretory droplets during normal speech may be a route for transmission of SARS-CoV-2 [2]. Talking creates droplets that can carry the virus, and this hypothesis also supports the transmission of SARS-CoV-2 by asymptomatic individuals. If we accept this possibility, it is necessary for everyone in the community to wear a mask.

There is conflicting evidence for airborne transmission of the virus. A number of studies have reported positive air sampling in closed environments and emphasize the airborne transmission of SARS-CoV-2 [3,4]. Factors such as short sampling time and poor knowledge of sampling operators about the dynamics of droplets and buildings airflow, can lead to a failure to identify SARS-CoV-2 in air samples. Therefore, all necessary measures should be taken to prevent air transmission of SARS-CoV-2, including improving the ventilation system by increasing the ventilation rate per hour, preventing air recirculation, reducing the number of people indoors and preventing direct exposure to a patient's air flow [4]. Airborne transmission emphasizes the importance of using face masks in public, crowded and closed places as the most important preventive measure.

Previous experience with coronaviruses has shown that a percentage of infections are related to nosocomial infections [5]. During the sudden onset of an epidemic, there is not enough time for personnel training, so it is crucial to prevent

intra-hospital transmission. Therefore, stricter infection prevention and control measures should be implemented in ventilation systems and surface disinfection, and access to personal protective equipment (masks, gloves, shields) should be facilitated. There are several possible routes of transmission: through respiratory droplets, airborne particles, aerosol-generating devices and methods, and contaminated surfaces [6]. However, the exact route of transmission in SARS-CoV-2 nosocomial infection is unknown [7].

In addition to nosocomial transmission in hospitals, we must also pay attention to intra-family transmission. In one study, 16.3% of household transmissions were reported by household contact tracing of index coronavirus disease 2019 (COVID-19) cases; indicating the high transmissibility of SARS-CoV-2 [6]. Household contact tracing of index COVID-19 cases can be applied as an important part of COVID-19 control programmes.

Although contact tracing is necessary and effective for controlling COVID-19, because of the presence of asymptomatic and pre-symptomatic transmission, it is not sufficient to interrupt transmission, so physical/social distancing should be implemented.

SARS-CoV-2 RNA has been detected from the faeces of infected individuals and from hospital toilet bowls. Although viral RNA detection is not equivalent to a viable virus, it is a trace of the virus, so faecal–oral transmission may be possible [5,8]. Angiotensin-converting enzyme 2 is present in the gastrointestinal tract, so SARS-CoV-2 may enter the gastrointestinal tract and replicate. As a result of the digestive symptoms in some patients and prolonged viral shedding in faeces, the virus appears to actively proliferate in the gastrointestinal tract [9]. Therefore, there is a possibility of infection transmission in toilets through the creation of aerosols when flushing toilets and through surfaces contact. The potential for faecal–oral transmission also emphasizes the importance of hand hygiene and washing.

There is conflicting evidence about vertical transmission. Some studies have followed infants born to infected pregnant women and taken pharyngeal samples for RT-PCR testing, but the results were negative and showed that the infants were not infected with SARS-CoV-2 [10]. Other studies did not rule out vertical transmission. In one study, PCR testing of neonatal pharyngeal samples was negative, but IgM and IgG antibodies against COVID-19 were positive on the day of birth. The mother's vaginal discharge was also negative [11]. In another study, 33 infants born to pregnant women with COVID-19 were screened, and three infants tested positive by PCR for SARS-CoV-2 on the second day of life [12]. SARS-CoV-2 nucleic acid has been detected in the placenta [13]. On the other side of the coin, there are studies that show the impossibility of vertical transmission: in one study, all products of pregnancy from two

pregnant women were negative or SARS-CoV-2 [10]. In general, because of the presence of angiotensin-converting enzyme 2 on placental villi and the uterus [14], vertical transmission can occur, although the risk seems very low.

In a number of studies, the SARS-CoV-2 genome was identified in blood samples from a number of patients with COVID-19 [15,16], which raised the question: Is SARS-CoV-2 transmitted through transfusion?

In one study, all blood samples taken from asymptomatic people with COVID-19 were negative for SARS-CoV-2 by PCR, and RNAemia was detected in severe and symptomatic cases. People with symptoms of infectious disease are not accepted by blood transfusion organizations, so there is no chance of transmission through transfusion, or the risk is very low. In addition, the viral load is low in serum and plasma. In previous viruses of this family (SARS and MERS coronaviruses), no cases of transfusion transmission have been reported [16]; the similarity of SARS-CoV-2 with SARS also supports the hypothesis of non-transmission through blood.

SARS-CoV-2 is present in saliva and faeces, and in theory it would be possible to transmit the virus through oral–anal intercourse [17], but this sexual habit is not common, so it is unlikely that this route will be a significant means of transmission.

In summary, considering the high transmission capacity of SARS-CoV-2, prolonged viral shedding, and the lack of a vaccine and systematic medication at this time, the most important action to limit infection is to cut off the transmission chain.

Conflict of interest

Authors declared no conflict of interest.

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