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Perspective

The relative transmissibility of asymptomatic COVID-19 infections among close contacts

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ABSTRACT

Asymptomatic transmission of the coronavirus disease 2019 is an important topic. A recent study in China showed that transmissibility of the asymptomatic cases is comparable to that of symptomatic cases. Here, we discuss that the conclusion may depend on how we interpret the data. To the best of our knowledge, this is the first time the relative transmissibility of asymptomatic COVID-19 infections is quantified.

Nishiura et al. (2020) estimated the asymptomatic ratio of COVID-19 was 41.6% (5 out of 12 confirmed cases) among 565 Japanese individuals evacuated from Wuhan, China. Mao et al. (2020) reported that 2 out of 78 confirmed cases are asymptomatic. One of the two cases showed RT-PCT positivity 15th days after first diagnosis. Mizumoto et al. (2020) estimated that the 17.9% of cases on the Diamond Princess Cruise Ship were asymptomatic case during the outbreak in February 2020. However, the transmissibility of asymptomatic case is unclear, and the positive RT-PCT results only imply the potential infectivity. It is important to study the patterns of viral shedding and live virus isolation. Wölfel et al. (2020) studied 9 hospitalized cases and found that live virus was isolated from throat and lung-derived samples up to 8 days after symptom onset. When the RNA concentration is above 10^6 copies per ml (or equivalent Ct-value lower than 24), but not from stool samples, despite of high virus RNA concentration. Above the threshold, high RNA concentration yields high probability of live virus isolation. This 'dose-response' association highlights a patient's RT-PCR level should be higher than a threshold to be effectively infectious.

Zou et al. (2020) monitored the viral shedding for 18 patients including 3 severe cases, 14 mild to moderate cases and 1 asymptomatic case. It was found that the viral shedding pattern of COVID-19 patients resembles that of influenza patients rather than that of SARS patients. The patterns of virus shedding in Zou et al. (2020) and Wölfel et al. (2020) are similar. These results explained the shorter serial interval and incubation period of COVID than that of SARS patients (Guan et al., 2020; Du et al., 2020). As of April 4, 2020, 150 asymptomatic cases were reported in Hong Kong out of 915 confirmed cases, giving a crude ratio of 16.4%. The weekly asymptomatic ratio showed interesting pattern in Figure 1 . In Hong Kong, asymptomatic cases are most likely from young imported cases, and in recent months, Hong Kong are facing a large number of relatively young imported cases.

The asymptomatic transmission of the COVID-19 is an important topic in understanding the transmissivity of COVID-19 (Qiu, 2020). To our knowledge, the transmissibility of asymptomatic cases has not been quantified. In a recent paper, Chen et al. (2020) investigated the transmissibility of asymptomatic cases among close contacts, and claimed no statistical difference between the transmissibility of asymptomatic cases versus that of symptomatic cases. In this work, we re-analysed their dataset, and argue that the transmissibility of asymptomatic cases could be lower than that of the symptomatic case by comparing the reproduction numbers.

According to the COVID-19 surveillance data in Chen et al. (2020), the first generation consist 161 symptomatic cases and 30 asymptomatic cases in Ningbo, China from Jan 20 to March 6, 2020.

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Table 1
Summary of the COVID-19 transmission and contact tracing in Ningbo from January 21 to March 6, 2020. The data are obtained from Chen et al. (2020).

	First generation	Close contacts	Second generation		
			Symptomatic	Asymptomatic	Sub-total
Symptomatic	161	2001	107	19	126
Asymptomatic	30	146	3	3	6
Total	191	2147	110	22	132

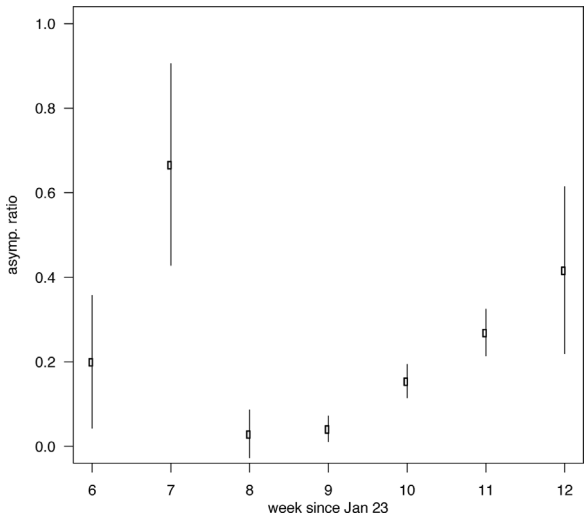

Figure 1. Weekly asymptomatic case ratio (out of weekly confirmed cases) in Hong Kong. Cases are grouped in weeks according to the laboratory confirmation date.

The symptomatic and asymptomatic groups have 2001 and 146 close contacts, respectively. The consecutive secondary infections consist 110 symptomatic cases and 22 asymptomatic cases, see Table 1 . According to Chen et al. (2020), the number of cases per contacts is calculated as (126/2001 =) 0.063 and (6/146 =) 0.041 for the symptomatic and asymptomatic groups respectively, and then concluded that the difference among the transmissibility of the two groups was not statistically significant.

Theoretically, the transmissibility (of an infectious disease) can be quantified by the reproduction number (R). The R is defined the ratio of the case counts in the first generation divided by those in the second generation, namely the number of secondary cases per index case, and thus it is proportional to the risk of infection, i.e., force of infection. Hence, by definition, the Rs can be calculated as (126/161 =) 0.78 and (6/30 =) 0.20 for the symptomatic and asymptomatic groups respectively. Therefore, the risk ratio (RR) of infectivity of a symptomatic group against that of the asymptomatic group is estimated at 3.9 (95%CI: 1.5–11.8). If focusing on symptomatic secondary infections, the RR is estimated at 6.6 (95% CI: 2.0–34.7).

In the classic 'SEIR' modelling framework, the basic reproduction number, $R_0 = \beta\gamma^{-1} = \rho\theta\gamma^{-1}$. Here, the γ^{-1} is the mean infectious period and the β is effective contact rate. The β can be formulated as $\beta = \rho\theta$, where θ is the average contact rate (common unit: contact per day) and the ρ is the risk (probability) of transmission per contact. Thus, the RR of the ρ of symptomatic group against the ρ of the asymptomatic group is estimated at [(126/2001]/(6/146)=] 1.5 (95%CI: 0.7–3.4). This indicates the symptomatic cases are likely to be more infectious than the asymptomatic cases though this difference is statistically insignificant. However, the mean infectious period (γ^{-1}) of a symptomatic case may be longer than that of an asymptomatic case hypothetically. Therefore, the combined effects of ρ and γ^{-1} probably lead to a higher reproduction number in the symptomatic group.

Additionally, Chen et al. (2020) showed that asymptomatic cases are more likely to produce asymptomatic cases relatively speaking, since the 6 secondary cases from asymptomatic primary cases consist 3 asymptomatic cases (50%). Whereas 19 out of 126 (15%) are asymptomatic from symptomatic primary cases. The odds ratio (OR) is estimated at 5.5 (95%CI: 0.7–44.4). We note that such a phenomenon may as well have occurred in the COVID-19 outbreak on the Diamond Princess cruise ship in February 2020 (Zhao et al., 2020), where a large proportion of asymptomatic cases were confirmed in the last 10 days of the quarantine period. Namely, asymptomatic COVID-19 cases may likely produce asymptomatic offspring.

This study contains limitation. Our analysis is conducted based on the contact tracing surveillance data. Referring to Table 1, the close contacts per primary case of the symptomatic group are [(2001/161)/(146/30)−1=] 1.6-fold (95%CI: 0.8–2.6) more than those of the asymptomatic group. On the one hand, the difference could be merely due to the difference in the contact pattern as pointed out (Chen et al., 2020), which would not affect our main results. On the other hand, this difference in the contact tracing might partially be due to the difference in the contact tracing surveillance scheme implemented on the two groups of the primary cases. In such case, the RR estimate may be higher than its true value. Cautious should be taken in interpreting these data, and understanding this gap would improve our conclusions.

In summary, we conclude that the relatively transmissibility of asymptomatic case could be significantly smaller than that of the symptomatic cases. The main contribution of Chen et al. (2020) is that they raise the alarm of the existence of the transmissibility of the asymptomatic cases. We remark that how efficient of the transmissibility of asymptomatic cases comparing to symptomatic cases warrants more study.

Declarations

Ethics approval and consent to participate

The ethical approval or individual consent was not applicable.

Availability of data and materials

All data and materials used in this work were publicly available.

Consent for publication

Not applicable.

Conflict of interest statement

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