Impact of contact tracing on SARS-CoV-2 transmission

As the far-reaching impacts of the coronavirus disease 2019 (COVID-19) pandemic expand to more and more countries, key questions about transmission dynamics and optimal intervention strategies remain unanswered. In particular, the age profile of susceptibility and infectivity, the frequency of super-spreading events, the amount of transmission in the household, and the contribution of asymptomatic individuals to transmission remain debated. The study by Qifang Bi and colleagues[1] in *The Lancet Infectious Diseases* explores some of these questions by analysing detailed contact tracing data from Shenzhen, a large and affluent city in southern China at the border with Hong Kong. To dissect the drivers of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission, the authors modelled PCR-confirmed infections in 391 cases and 1286 of their close contacts from Jan 14 to Feb 12, 2020.[1]

Shenzhen is an interesting location to study the dynamics of SARS-CoV-2 because it was affected early in the pandemic and reacted quickly.[2] Strict case isolation, contact tracing, and social distancing measures kept the transmission rate near the epidemic threshold throughout the study period.[2] Bi and colleagues report that most secondary infections occurred in the household (77 of 81), with a secondary attack rate estimated at 11·2% (95% CI 9·1–13·8) among household contacts.[1] This figure should be considered an underestimate of the unmitigated household attack rate of SARS-CoV-2, since transmission chains were cut short in Shenzhen because of strict control measures. Index cases detected by symptom-based surveillance were isolated outside of the home on average 4·6 days (95% CI 4·1–5·0) after symptom onset. Furthermore, individuals identified via contact tracing were isolated or quarantined outside of the home on average 2·7 days (95% CI 2·1–3·3) after symptom onset.[1] Consequently, the serial interval of SARS-CoV-2 in Shenzhen (mean estimate 6·3 days; 95% CI 5·2–7·6) should be considered a lower bound and would probably increase in less successfully controlled outbreaks.

The age profile of PCR-confirmed infections in Shenzhen indicates that children are as susceptible to SARS-CoV-2 infection as adults, although they are less likely to display symptoms.[1] The distinctive age profile of COVID-19 severity has been noted very early on in the pandemic,[3] although the biological mechanisms at play remain unclear. In the Shenzhen data, the authors noted no difference in the transmission potential of SARS-CoV-2 from children or adults.[1] This is in contrast to pandemic influenza virus, which is more easily transmitted by children. It will be useful to confirm the age profile of SARS-CoV-2 transmissibility with data from other locations and serological surveys, which capture more infections than PCR. Age-specific susceptibility, infectivity, and severity are important factors to get right to project the impact of school closures on SARS-CoV-2 dynamics and disease burden. School closures exert a substantial economic toll on societies and maintaining these interventions for long periods of time requires robust supportive evidence.

As would be expected from a well controlled outbreak, the mean R in Shenzhen was very low, at 0·4,[1] substantially reduced from a baseline non-intervention value of 2·0–4·0.[4] This aligns with the strict interventions implemented in this city. However, the mean R does not tell the full story. There is evidence of transmission heterogeneity with SARS-CoV-2, with 10% of cases accounting for 90% of transmission.[1] Such a high level of heterogeneity is consistent with, if a little more extreme than, that of SARS-coronavirus (SARS-CoV), and more pronounced than for other directly transmitted respiratory viruses such as measles or influenza.[5] Beyond the intensity of contacts, there is no clear factor in the Shenzhen data that could explain the high transmission potential of some infections. Further research into the biological (eg, shedding and symptoms) and social factors (eg, type of contacts and environment) that drive transmission heterogeneity is warranted to guide more targeted interventions against SARS-CoV-2.

Armed with their descriptive findings, Bi and colleagues go on to simulate the impact of case isolation and contact tracing on SARS-CoV-2 dynamics.[1] They consider a range of possible durations for the infectious period of SARS-CoV-2, which is reasonable given the scarcity of data on this figure. They show that for a given R, the longer the infectious period, the more easily the epidemic can be brought under control with case-based interventions. This is because case isolation reduces the full transmission potential of each case, particularly if

the infectious period is long and cases can be isolated 2–5 days after symptom onset. Furthermore, Bi and colleagues show that contact-based interventions are more efficient than case-based interventions to reduce transmission, since infected contacts are typically isolated earlier in their infection history than index cases. This worthwhile modelling exercise highlights the urgent need for more information about the infectious period of SARS-CoV-2.

However, there is an important caveat in this modelling work: the potential for pre-symptomatic and asymptomatic transmission is not considered. As a result, the conclusion that case-based or contact-based interventions alone could bring the epidemic under control for longer durations of the infectious period is optimistic, and contrasts with previous simulation studies.[6] Viral shedding studies and epidemiological investigations suggest that in the household, around 40% of transmission occurs before symptom onset, the live virus is shed for at least 1 week after symptom onset, and there is high shedding in asymptomatic individuals.[7–9] Crucially, the effectiveness of case isolation and contact tracing will depend on the fraction of transmission originating from asymptomatic and pre-symptomatic individuals.[9]

As we look towards post-lockdown strategies, we should examine the experience of countries that have successfully controlled SARS-CoV2 transmission or have low mortality (eg, China, Singapore, Taiwan, South Korea, Germany, and Iceland). Successful strategies include ample testing and contact tracing, supplemented by moderate forms of social distancing.[10] Contact tracing on the scale that is needed for the SARS-CoV-2 response is labour intensive, and imperfect if done manually. Hence new technology-based approaches are greatly needed to assist in identification of contacts, especially if case detection is aggressive.[9] Building on the SARS-CoV-2 experience in Shenzhen and other settings, we contend that enhanced case finding and contact tracing should be part of the long-term response to this pandemic—this can get us most of the way towards control.[9]

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