



$r = -0.02$ ; and  $E$  gene  $r = -0.16$ ), whereas the correlation of the  $C_t$  values with duration of faecal sample positivity was only significant for  $RdRp$  ( $p = 0.033$ ;  $N$  gene  $p = 0.91$ ;  $E$  gene  $p = 0.33$ ).

Our data suggest the possibility of extended duration of viral shedding in faeces, for nearly 5 weeks after the patients' respiratory samples tested negative for SARS-CoV-2 RNA. Although knowledge about the viability of SARS-CoV-2 is limited,<sup>1</sup> the virus could remain viable in the environment for days, which could lead to faecal-oral transmission, as seen with severe acute respiratory virus CoV and Middle East respiratory syndrome CoV.<sup>2</sup> Therefore, routine stool sample testing with real-time RT-PCR is highly recommended after the clearance of viral RNA in a patient's respiratory samples. Strict precautions to prevent transmission should be taken for patients who are in hospital or self-quarantined if their faecal samples test positive.

As with any new infectious disease, case definition evolves rapidly as knowledge of the disease accrues. Our data suggest that faecal sample positivity for SARS-CoV-2 RNA normally lags behind that of respiratory tract samples; therefore, we do not suggest the addition of testing of faecal samples to the existing diagnostic procedures for COVID-19. However, the decision on when to discontinue precautions to prevent transmission in patients who have recovered from COVID-19 is crucial for management of medical resources. We would suggest the addition of faecal testing for SARS-CoV-2.<sup>3</sup> Presently, the decision to discharge a patient is made if they show no relevant

symptoms and at least two sequential negative results by real-time RT-PCR of sputum or respiratory tract samples collected more than 24 h apart. Here, we observed that for over half of patients, their faecal samples remained positive for SARS-CoV-2 RNA for a mean of 11.2 days after respiratory tract samples became negative for SARS-CoV-2 RNA, implying that the virus is actively replicating in the patient's gastrointestinal tract and that faecal-oral transmission could occur after viral clearance in the respiratory tract.

Determining whether a virus is viable using nucleic acid detection is difficult; further research using fresh stool samples at later timepoints in patients with extended duration of faecal sample positivity is required to define transmission potential. Additionally, we found patients normally had no or very mild symptoms after respiratory tract sample results became negative (data not shown); however, asymptomatic transmission has been reported.<sup>4</sup> No cases of transmission via the faecal-oral route have yet been reported for SARS-CoV-2, which might suggest that infection via this route is unlikely in quarantine facilities, in hospital, or while under self-isolation. However, potential faecal-oral transmission might pose an increased risk in contained living premises such as hostels, dormitories, trains, buses, and cruise ships.

Respiratory transmission is still the primary route for SARS-CoV-2 and evidence is not yet sufficient to develop practical measures for the group of patients with negative respiratory tract sample results but positive faecal samples. Further research into the

viability and infectivity of SARS-CoV-2 in faeces is required.

We declare no competing interests. This work was supported by grants from National Science and Technology Key Projects for Major Infectious Diseases (2017ZX10302301-002), National Natural Science Foundation of China (31470877), Guangzhou Science and Technology Planning Project (201704020226 and 201604020006), Guangdong Natural Science Foundation (2015A030311009), and National Key Research and Development Program of China (2016YFC1200105). YW, CG, and LT contributed equally. HS, GJ, and XH are joint senior authors.

Yongjian Wu, Cheng Guo,  
Lantian Tang, Zhongsi Hong,  
Jianhui Zhou, Xin Dong, Huan Yin,  
Qiang Xiao, Yanping Tang, Xiujuan Qu,  
Liangjian Kuang, Xiaomin Fang,  
Nischay Mishra, Jiahai Lu, Hong Shan,  
Guanmin Jiang, Xi Huang  
huangxi1312@163.com

Center for Infection and Immunity, Fifth Affiliated Hospital, Sun Yat-sen University, Zhuhai, Guangdong Province, 519000, China (YW, LT, ZH, JZ, XD, HY, QX, YT, XQ, LK, XF, GJ, XH); Center for Infection and Immunity, Mailman School of Public Health, Columbia University, New York, NY, USA (CG, NM); School of Public Health, Sun Yat-sen University, Guangzhou, Guangdong Province, China (JL); and Guangdong Provincial Engineering Research Center of Molecular Imaging, Guangdong Provincial Key Laboratory of Biomedical Imaging, and Department of Interventional Medicine, Fifth Affiliated Hospital, Sun Yat-sen University, Zhuhai, Guangdong Province, China (HS)

- 1 Goh GK-M, Dunker AK, Foster JA, Uversky VN. Rigidity of the outer shell predicted by a protein intrinsic disorder model sheds light on the COVID-19 (Wuhan-2019-nCoV) infectivity. *Biomolecules* 2020; **10**: e331.
- 2 Yeo C, Kaushal S, Yeo D. Enteric involvement of coronaviruses: is faecal-oral transmission of SARS-CoV-2 possible? *Lancet Gastroenterol Hepatol* 2020; published online Feb 19. [https://doi.org/10.1016/S2468-1253\(20\)30048-0](https://doi.org/10.1016/S2468-1253(20)30048-0).
- 3 Munster VJ, Koopmans M, van Doremalen N, van Riel D, de Wit E. A novel coronavirus emerging in China - key questions for impact assessment. *N Engl J Med* 2020; **382**: 692-94.
- 4 Bai Y, Yao L, Wei T, et al. Presumed asymptomatic carrier transmission of COVID-19. *JAMA* 2020; published online Feb 21. DOI:10.1001/jama.2020.2565.