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Opinion

Put a lid on it: are faecal bio-aerosols a route of transmission for SARS-CoV-2?

C.V. McDermott^{a,b,*}, R.Z. Alicic^{a,b,c}, N. Harden^d, E.J. Cox^c, J.M. Scanlan^e

^a Providence Sacred Heart Medical Center & Children's Hospital, Spokane, WA, USA

^b University of Washington School of Medicine, Seattle, WA, USA

^c Providence Medical Research Center, Spokane, WA, USA

^d MultiCare Valley Hospital, Spokane Valley, WA, USA

^e Swedish Center for Research and Innovation, Seattle, WA, USA

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Gastrointestinal manifestations of coronavirus disease 2019 (COVID-19) are immediately reminiscent of previous coronavirus outbreaks and should raise concern about faecal shedding as a mode of transmission in hospital settings. Severe acute respiratory syndrome coronavirus 1 (SARS-CoV-1), the

coronavirus that caused SARS, was primarily transmitted by droplets and personal contact. However, analysis of a community cluster of SARS in Hong Kong that originated from an index patient with diarrhoea suggested that faecal shedding and air movement of contaminated bio-aerosols was a major contributor to the 187-person outbreak [1]. Similarly, airborne SARS probably contributed to another large hospital outbreak [2]. Bio-aerosols containing live pathogens can be produced by toilet flushing [3], and 95% of droplets produced by flushing are small enough to present an airborne infection concern ($\leq 2 \mu\text{m}$) [4]. Thus, transmission of virus shed in faeces through bio-aerosols may be an under-recognized infection control issue for healthcare facilities with high numbers of patients shedding virus in stool.

Months into the COVID-19 pandemic, it is well recognized that COVID-19 patients have gastrointestinal symptoms including diarrhoea and shed virus in stool [5]. Faecal shedding seems to occur in patients without gastrointestinal symptoms [6], which could enable asymptomatic individuals with no respiratory symptoms to be a source of faecal transmission. While research on this route is ongoing, the potential for transmission should not be underestimated: recently published data from China reported presumed transmission of SARS-CoV-2 from one patient with gastrointestinal symptoms to 10 healthcare workers and four other patients [7].

Faecal bio-aerosol transmission may be overlooked in a hospital setting because it is not a commonly discussed source of pathogenic aerosols. Inoculation by exposure to contaminated surfaces is the typically understood route of transmission for a pathogen with demonstrated gastrointestinal shedding. However, toilet flushing also generates droplet nuclei that are small enough to both contaminate surfaces and become airborne [4]. While little to no research is available on the production of infectious bio-aerosols containing specific pathogens, including SARS-CoV-2, the presence of pathogens

* Corresponding author. Address: Faculty, Internal Medicine Residency Spokane, Spokane Teaching Health Center, Faculty Hospitalist, Sacred Heart Medical Center, Clinical Instructor, University of Washington School of Medicine, 101 W. 8th Ave., Spokane, WA, 99204, USA. Tel.: +509 474 3022; fax: +509 474 5316.

E-mail address: Carmen.McDermott@providence.org (C. V. McDermott).

such as *Clostridioides difficile* in hospital air is substantially increased by toilet flushing [8]. Already, evidence of SARS-CoV-2 contamination of surface and air samples outside of isolation rooms [9], and experimental data showing that SARS-CoV-2 can live in aerosols for 3 h [10] should raise concerns about this mode of transmission and prompt additional research.

Additional research on this topic is needed, but the questions that are immediately relevant to infection control are: (1) Does toilet flushing produce bio-aerosolized and viable SARS-CoV-2 to a similar or lesser degree compared with clinical aerosolizing procedures, such as nebulizer treatments? (2) Under certain conditions, could bio-aerosols containing viable SARS-CoV-2 be re-circulated in the ventilation systems of healthcare facilities and public buildings? (3) Given that bio-aerosols penetrate alveolar tissue, does exposure to bio-aerosols from toilets cause more severe disease than contact with respiratory droplets, and could this route of exposure put healthcare workers, hospitalized patients, and environmental services staff at higher risk of severe or critical disease?

These questions have not yet been answered. However, given the urgent and emerging nature of this illness, the apparent increased infectiousness of SARS-CoV-2 compared with earlier coronaviruses, and the lack of clinical experience with this pathogen, it would be prudent for hospitals to exercise precautions as part of infection control initiatives. Precautions may be simple: for example, hospitals may advise covering toilets or using non-flushing commodes, and ensuring robust environmental decontamination protocols. Implementing these precautions now based on information that was previously learned from SARS can help healthcare facilities prevent similar patterns of transmission for SARS-CoV-2.

This is not the first coronavirus outbreak that global hospital systems have encountered, and it is not likely to be the last. Management of COVID-19 should be guided by the wealth of information available from previous outbreaks, which clearly demonstrated faecal shedding and the potential for bio-aerosolization of the pathogen. Faecal bio-aerosol transmission is particularly concerning for healthcare workers, who are already at higher risk of infection from SARS-CoV-2 than the general public, especially with shortages of personal protective equipment. Exercising simple precautions and raising awareness about all routes of transmission, including faecal bio-aerosols, will help hospitals control both nosocomial infection and healthcare worker exposure.

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