Infection Prevention in Practice 6 (2024) 100353

Available online at www.sciencedirect.com

Infection Prevention in Practice

journal homepage: www.elsevier.com/locate/ipip

Letter to the Editor

Environmental surveillance of SARS-CoV-2 for COVID-19 outbreak detection in hospital: a single-centre prospective study

Dear Sir/Madam,

Early identification of COVID-19 outbreaks in hospitals requires active surveillance. Typical surveillance involves daily systematic review of symptoms in hospitalized patients. However, this approach does not account for pre-symptomatic or asymptomatic patients, and COVID-19 outbreaks continue to pose a challenge in healthcare settings. Environmental surveillance (e.g., wastewater surveillance, built environment sampling) may be an effective method for active surveillance [1—4]. In a previous 14-month study, we collected environmental surface samples from the floors at 10 long-term care homes and identified that the percentage of floor swabs positive for SARS-CoV-2 was predictive of an impending COVID-19 outbreak (AUC 0.84) [1]. During non-outbreak periods, 22% of floor swabs were positive for SARS-CoV-2; during COVID-19 outbreaks, floor swab positivity rose to 54%. Floor swab positivity also mirrored outbreak activity: as outbreaks worsened, the percentage of positive floor swabs rose, and as outbreaks resolved, the percentage of positive floor swabs fell. This study's objective was to assess if floor swab positivity follows a similar pattern before and after a COVID-19 outbreak in the inpatient unit of a hospital.

We conducted a 32-week prospective study at Mount Sinai Hospital, a tertiary care hospital located in Toronto, Canada. We collected floor swab samples along hallways outside patient rooms from one of the general internal medicine floors from October 31, 2022—June 15, 2023 (Appendix Figure 1). Floor swabs were performed using previously validated protocols [5] and involved swabbing across 5 x 5 centimetre areas using the P-208 Environmental Surface Collection Prototype kit (DNA Genotek). The quantitative reverse transcriptase-PCR (RT-qPCR) results provided a quantification cycle (Cq) value for each positive swab, which was subsequently converted into copy numbers of the virus using a standard curve detailed in previously validated methods [5].

An outbreak was defined by Mount Sinai Hospital as two cases of COVID-19 within a 14-day period where both could reasonably have been acquired in the hospital. A suspected outbreak was defined as two nosocomial cases of COVID-19 with no link to one another, identified within 7 days. A suspected outbreak only leads to a declared outbreak if additional COVID-19 cases are evident after 5—7 days of calling the suspected outbreak. During the study period, the following two COVID-19 outbreaks were declared on the ward: December 20, 2022 to January 8, 2023 (19 days) and March 17, 2023 to March 30, 2023 (13 days). A suspected outbreak was announced on April 11, 2023 but did not lead to a declared outbreak.

Descriptive statistics for the percentage of positive floor swabs and copy numbers of the virus over time were reported. Because the copy numbers were not normally distributed, non-parametric tests were performed to compare copy numbers before and after an outbreak.

During the 32-week period, 182 swabs were collected on 21 separate days. The overall floor swab positivity for SARS-CoV-2 was 98.4%. During COVID-19 outbreak periods, the floor swab positivity was 100%, and during non-outbreak periods it was 98.0%. Since positivity was consistently near 100%, we also assessed viral copy number as a predictor. The median viral copy number throughout the duration of the study was 279 (interquartile range [IQR], 68 to 1230). During COVID-19 outbreak periods, the median viral copy number was 653 (IQR, 300 to 1754) and during non-outbreak periods it was 210 (IQR, 49 to 1018). In Figure 1, we provide a graphical representation of how viral copy numbers changed over time. Two COVID-19 outbreaks occurred during the 32-week period, and an increase in viral material (i.e., number of copies) is evident prior to the declaration of each outbreak, and number of copies remains high during the outbreak period (Figure 1).

Our study demonstrates that while the percentage of floor swabs positive for SARS-CoV-2 was near 100% regardless of the presence of a COVID-19 outbreak, the number of detected viral copies mirrored the COVID-19 outbreak status. We identified that viral copy numbers were typically highest at the start of an outbreak and fell toward the end of an outbreak.

Our study aligns with previous viral detection studies conducted in patient care settings [6—8]. Previously, we and others have proposed the use of floor swab positivity to predict COVID-19 outbreaks. However, this approach is unsuitable in settings with persistently high swab positivity

https://doi.org/10.1016/j.infpip.2024.100353

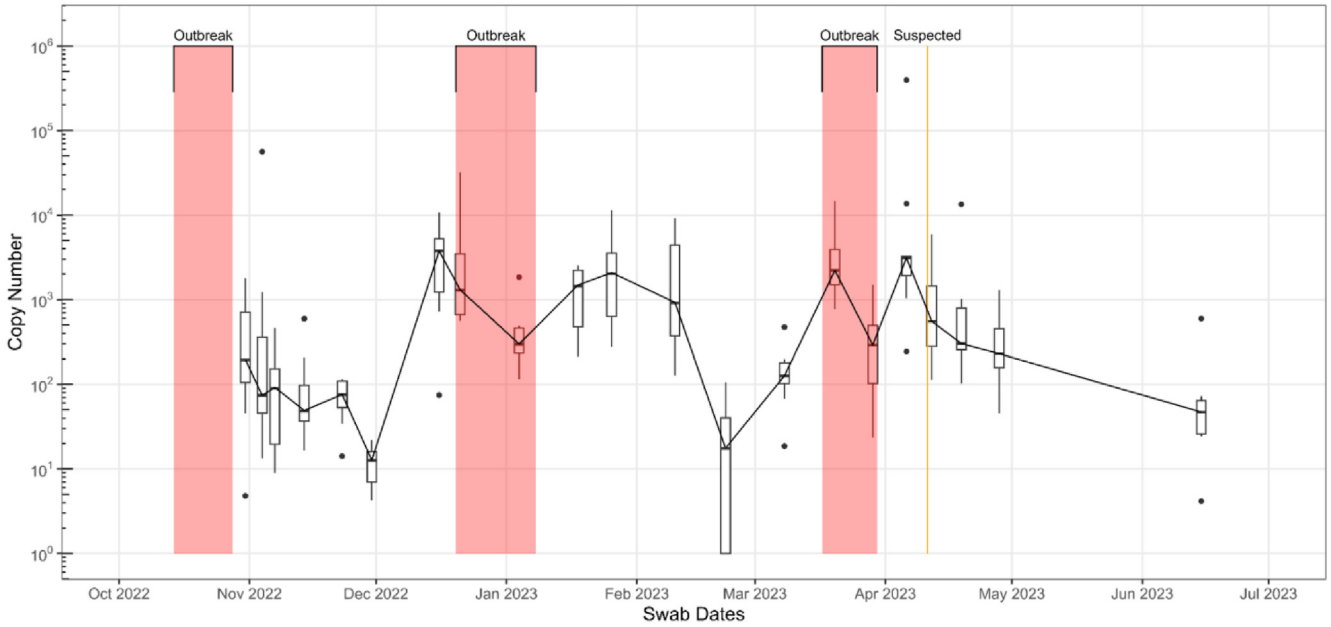


Figure 1. SARS-CoV-2 viral copy numbers on the floors of the inpatient ward on log scale. One outbreak ended just prior to the study period. Two outbreaks and one suspected outbreak occurred during the 32-week study period, highlighted in red and orange respectively.

(i.e., approaching 100%). Nearly 100% of our hospital floor swabs were positive for SARS-CoV-2, regardless of outbreak status. This differs from our previous study conducted in long-term care homes, in which floor swab positivity was significantly different between outbreak and non-outbreak periods. Long-term care homes strive to minimize the number of COVID-19—positive residents—typically, residents with COVID-19 are transferred to hospital. Hospital wards, on the other hand, regularly admit patients with COVID-19, which likely explains the consistent detection of SARS-CoV-2 on the hospital floor. By analyzing the number of viral copies of SARS-CoV-2 instead of percentage positivity of the hospital floor swabs, we obtained a clearer view of changes in viral load over time.

An important limitation of our study is that it was a single-centre evaluation. However, the results align with our prior multicentre prospective study that included 23 outbreaks over a 14-month period across 10 long-term care homes [1]. Future studies will be needed to validate our findings and assess whether environmental surveillance can help inform infection control measures in hospitals.

Author contribution

Study concept and design: All authors
Acquisition of data: All authors
Analysis/interpretation of data: All authors
Drafting of the manuscript: Ray P, Fralick M
Critical revision of the manuscript: All authors
Statistical analysis: All authors

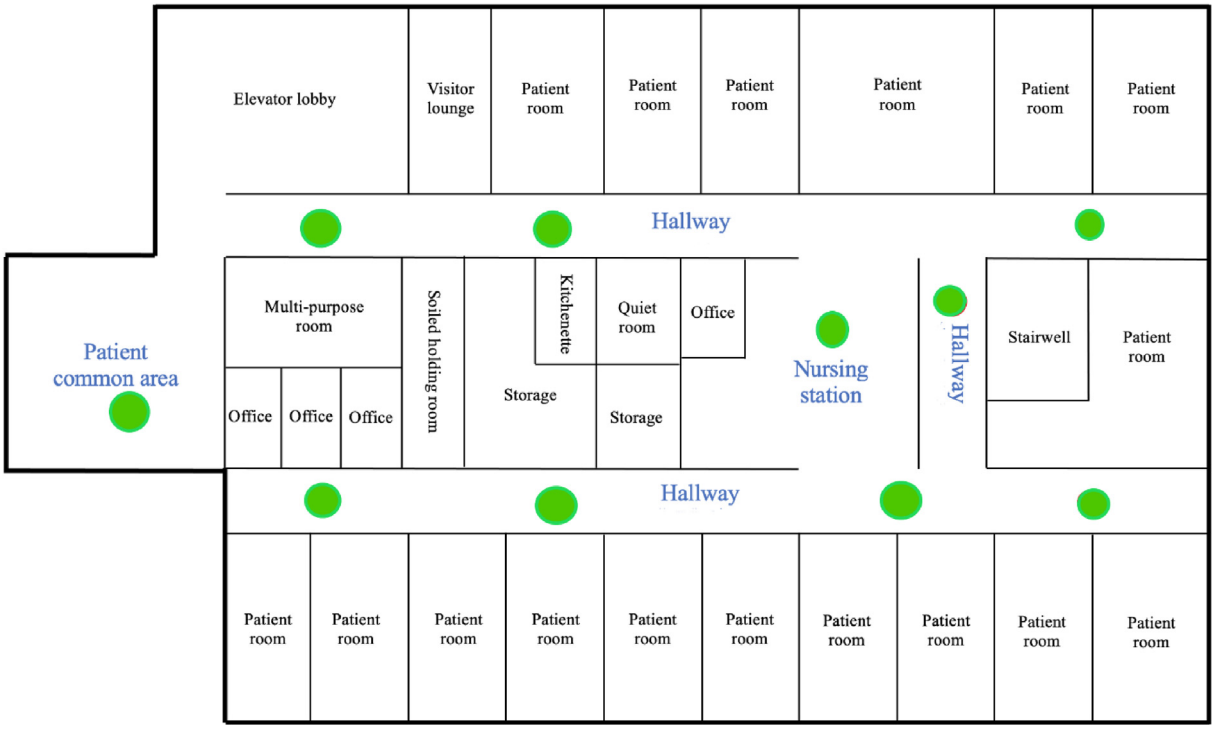
Funding statement

This project was supported by a CIHR Operating Grant (EGA 179419) and the Sinai Health Department of Medicine Research Fund.

Conflicts of interest

MF is an advisor to Signal1, a start-up company that implements machine-learned solutions into clinical practice; in addition, he was a consultant for ProofDx, a start-up company that created a point-of-care device for COVID-19 using CRISPR.

Appendix



Appendix Figure 1. Floor map for the internal medicine ward where swabbing occurred. All samples were taken from the floor. Green circles indicate swabbing locations (i.e., hallways, nursing station, and patient common area).

References

[1] Fralick M, Nott C, Moggridge J, Castellani L, Raudanskis A, Guttman DS, et al. Detection of covid-19 outbreaks using built environment testing for SARS-CoV-2. NEJM Evid [Internet] 2023 Feb 28;2(3). Available from: https://evidence.nejm.org/doi/abs/10.1056/EVIDoa2200203.

[2] Fralick M, Burella M, Hinz A, Mejbel HS, Guttman DS, Xing L, et al. The spatial and temporal distribution of SARS-CoV-2 from the built environment of COVID-19 patient rooms: A multicentre prospective study. PLoS One 2023 Mar 13;18(3):e0282489.

[3] Manuel DG, Delatolla R, Fisman DN, Fuzzen M, Graber T, Katz GM, et al. The role of wastewater testing for SARS-CoV-2 surveillance [Internet]. Ontario COVID-19 Science Advisory Table; 2021 Aug [cited 2023 Jun 29]. Available from: https://uwspace.uwaterloo.ca/handle/10012/18398.

[4] Coil DA, Albertson T, Banerjee S, Brennan G, Campbell AJ, Cohen SH, et al. SARS-CoV-2 detection and genomic sequencing from hospital surface samples collected at UC Davis. PLoS One 2021 Jun 24;16(6):e0253578.

[5] Hinz A, Xing L, Doukhanine E, Hug LA, Kassen R, Ormeci B, et al. SARS-CoV-2 detection from the built environment and wastewater and its use for hospital surveillance. Facets (Ott) 2022 Jan 1;7:82—97.

[6] Minich JJ, Ali F, Marotz C, Belda-Ferre P, Chiang L, Shaffer JP, et al. Feasibility of using alternative swabs and storage solutions for paired SARS-CoV-2 detection and microbiome analysis in the hospital environment. Microbiome 2021 Jan 22;9(1):25.

[7] Ong SWX, Tan YK, Chia PY, Lee TH, Ng OT, Wong MSY, et al. Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. JAMA 2020 Apr 28;323(16):1610—2.

[8] Ziegler MJ, Huang E, Bekele S, Reesey E, Tolomeo P, Loughrey S, et al. Spatial and temporal effects on severe acute respiratory coronavirus virus 2 (SARS-CoV-2) contamination of the healthcare environment. Infect Control Hosp Epidemiol 2022 Dec;43(12):1773—8.

Prachi Ray[a], Bryant Lim[b], Katarina Zorcic[a], Jennie Johnstone[c,d], Aaron Hinz[e,f], Alexandra M.A. Hicks[e,f], Alex Wong[f,g], Derek R. MacFadden[h,i], Caroline Nott[h,i], Lucas Castellani[j,k], Rees Kassen[e], Michael Fralick[a,b,*]

[a]*Department of Medicine, Sinai Health System, Toronto, ON, Canada*

[b]*Department of Medicine, University of Toronto, Toronto, ON, Canada*

[c]*Infection Prevention and Control, Sinai Health System, Toronto, ON, Canada*

[d]*Department of Laboratory Medicine and Pathobiology, University of Toronto, Toronto, ON, Canada*

[e]*Department of Biology, University of Ottawa, Ottawa, ON, Canada*

[f]*Department of Biology, Carleton University, Ottawa, ON, Canada*

[g]Institute for Advancing Health Through Agriculture, Texas A&M University, College Station, TX, USA

[h]The Ottawa Hospital Research Institute, Ottawa, ON, Canada

[i]Department of Medicine, University of Ottawa, Ottawa, ON, Canada

[j]Division of Clinical Sciences, NOSM University, Sudbury, ON, Canada

[k]Department of Infection Prevention and Control, Sault Area Hospital, Sault Ste. Marie, ON, Canada

* Corresponding author. Address: Sinai Health System, 60 Murray Street, M5T 3L9, Canada.
E-mail address: mike.fralick@mail.utoronto.ca (M. Fralick)

Available online 5 March 2024