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SYNOPSIS

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Review of "Characterization of Hospital Airborne SARS-CoV-2"

Article citation: Stern RA, Koutrakis P, Martins MAG, Lemos B, Dowd SE, Sunderland EM, et al. Characterization of hospital airborne SARS-CoV-2. Respir Res. 2021;22(1):73. Available from: https://doi.org/10.1186/s12931-021-01637-8

One-minute summary

- The authors examined the size of particles and locations associated with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) RNA in an acute care hospital environment in locations outside of Coronavirus Disease 2019 (COVID-19) patient care areas.
- For each 48-hour sampling period (n=6), air samples for the three particle size ranges were collected simultaneously at five locations in a 134-bed hospital in Boston, Massachusetts between April 29 and May 22, 2020.
  - Outside the entrance to a COVID-19 intensive care unit (ICU)
  - Entrance to a COVID-19 ward (CW1)
  - A personal protective equipment donning room outside a COVID-19 ward (CW2)
  - A workstation in the emergency department (ED)
  - A nursing station outside a non-COVID-19 ward (NCW)
- For each location and sampling period, sampling was performed for three particle size ranges (>10.0 µm, 10.0–2.5 µm and ≤2.5 µm).
- **Overall 8/90 (9%) of air samples were positive for SARS-CoV-2 RNA.**
  - 2/8 were fine particles ≤2.5µm in size (ED=1, ICU=1).
  - 3/8 were course particles 10.0-2.5µm (ICU=1, NCW=2).
  - 3/8 were large particles >10.0µm (ICU=1, NCW=2).
- Concentrations of samples ranged from 5 to 51 copies m^{-3}.
- Designated wards for COVID-19 patients (under negative pressure: CW1, CW2, ICU) did not appear to increase the likelihood of detecting viral RNA, having higher viral concentration, or finding particles of specific sizes in air samples.
  - **ED** was observed to have the highest concentrations at 51 and 8 copies m^{-3} with 2/18 (11%) positive samples.
  - **NCW** had the second highest concentration at 47, 12 and 5 copies m^{-3} with 3/18 (17%) positive samples.
  - **ICU** had 2/18 (11%) samples testing positive (concentrations 7, 5 copies/m^3).
  - **CW1** had 1/18 (6%) positive samples (concentration 9 copies/m^3); however, this was during a period of time when the ward was closed for cleaning with no patients present.
  - **CW2** had no positive samples; 0/18 (0%).

- The probability of finding SARS-CoV-2 RNA across all air samples was positively associated with the number of COVID-19 patients in the hospital (r=0.95, P<0.01), which in turn was positively associated with the daily COVID-19 incidence in Massachusetts (r=0.99, P<0.01). However, it was noted:
  - The probability of a positive air sample in the ED was neither associated with the number of patients present nor the number of patients with respiratory complaints.
  - The two samples with the highest viral concentrations were not taken during the time of the peak number of COVID-19 patients in hospital.
- The areas where staff congregated during times of high community rates of COVID-19 was associated with positive air samples for SARS-CoV-2 RNA. The authors speculated that negative pressure units were effective in limiting airborne exposure to SARS-CoV-2 outside those units.

Additional information

- Micro-environmental cascade impactors that simultaneously collect air samples of the three particle sizes were placed at breathing zone (48–56 inches above the floor) at each sampling location.
- The only positive sample from CW1 was collected between May 11 and 13, 2020, when the unit was closed for cleaning between May 12 and 18, 2020. The unit was not under negative pressure during the cleaning period and ward doors were left open for cleaning staff, who had to pass by the air sampler to access the area for cleaning.
- A significant positive association was observed between the average number of COVID-19 patients staying in the hospital during each sampling period and the likelihood of an air sample testing positive for SARS-CoV-2 RNA:
  - April 29–May 1: 35 patients in hospital; 3/15 samples positive
  - May 5–May 7: 24 patients in hospital; 2/15 samples positive
  - May 11–May 13: 17 patients in hospital; 2/15 samples positive
  - May 13–May 15: 14 patients in hospital; 1/15 samples positive
  - May 18–May 20: 9 patients in hospital; 0/15 samples positive
  - May 20–May 22: 7 patients in hospital; 0/15 samples positive
- Viral concentration in air samples was quantified by reverse transcription quantitative polymerase chain reaction.
- COVID-19 prevention policies in place during the sampling period included universal masking for staff and patients when outside their rooms, visitation restrictions and universal testing for COVID-19 on admission.
- The detection of viral RNA does not by itself indicate a risk of transmission as the infectivity of those viral particles and the infective dose of SARS-CoV-2 is unknown.

PHO reviewer's comments

- In this study, the authors collected air samples of 3 different size fractions in a hospital in Massachusetts. The number of positive samples was small and the probability of a positive sample was equally distributed among the size ranges and associated with community COVID-19 incidence. This study also notes that positivity did not seem to be associated with the location of COVID-19 patients, but with staff. The authors attributed this observation with the effectiveness of negative-pressure ventilation systems in patient care areas. There are other non-ventilation

factors that may have also contributed to a positive sample, including the timing of infection (patients are likely to be later in their illness course compared to staff), crowding in work areas, re-suspension of particles from cleaning, and differences in personal protective equipment use and staff behaviours at work stations compared to patient care areas.

- The authors did not reference the numerous studies that have not detected SARS-CoV-2 RNA in hospital air samples.[1] Few studies have identified culture-positive SARS-CoV-2 from air samples which were positive by polymerase chain reaction. This study did not attempt viral cultures of positive samples.
- This study did not evaluate nosocomial transmission based on positivity of air samples. Further research evaluating the association between the presence of SARS-CoV-2 RNA in air samples and infection risk would be of interest.
- Notably, two samples in non-patient care areas detected fine particles ≤2.5 µm in size, raising the possibility of long-range aerosol transmission occurring. However, this study did not demonstrate that these particles were infectious.
- The findings in this study also suggest that nosocomial infection risk may be related to staff infection and community COVID-19 rates more than from COVID-19 infected patients. This observation is consistent with known transmission dynamics of SARS-CoV-2 as the highest risk of transmission is in the presymptomatic or early symptomatic period.[2-5]

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