

Presymptomatic Transmission of SARS-CoV-2 Amongst Residents and Staff at a Skilled Nursing Facility: Results of Real-Time PCR and Serologic Testing

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Abstract

High rates of asymptomatic infection suggest benefits to routine testing in congregate care settings. SARS-CoV-2 screening was undertaken in a single nursing facility without a known case of COVID-19, demonstrating an 85% prevalence among residents and 37% among staff. Serology was not helpful in identifying infections.

Key words: SARS-CoV-2, Skilled Nursing Facility, Serology

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Background

Older and chronically ill people represent a population at particularly high risk of morbidity from COVID-19, the disease caused by the SARS-CoV-2 virus [1-4]. Local and national public health agencies implemented regulations in March 2020 to protect older patients residing in congregate settings, including elimination of visitors and requirements to screen staff and residents. Despite these measures, high infection rates have been reported in skilled and long-term care facilities, though generally after recognition of cases within the facility. We report universal testing of presumed asymptomatic residents and selected staff at a skilled nursing facility consisting of both long-term and short-term care. A subset of residents and staff also underwent serologic testing for SARS-CoV-2 antibodies.

Methods

Setting & Design

A 142-bed skilled nursing facility in Massachusetts separated into short-term care, long-term care, and a memory unit, was selected as part of a statewide plan to establish a dedicated COVID-19 rehabilitation center, requiring relocation of the entire resident population. At the time of selection, no confirmed or suspected cases of COVID-19 were present among residents or staff. Based on emerging reports of asymptomatic spread at similar facilities, universal testing for SARS-CoV-2 was recommended by the Commonwealth of Massachusetts Department of Public Health prior to resident relocation [5, 6].

On April 1, six paramedics collected nasopharyngeal swab specimens from all 97 residents. On April 5, six paramedics and one physician collected swabs from 45 residents initially negative for SARS-CoV-2; 31 of these residents also had blood drawn for serologic testing. On April 6, six paramedics and two phlebotomists collected nasopharyngeal samples from 97 staff members and blood samples for serology from 84 staff members and an additional 25 residents (Figure 1). All personnel collecting nasopharyngeal or blood specimens used N95 respirators, eye protection, gloves, and impermeable gowns in accordance with infection control guidelines.

Laboratory testing

PCR for SARS-CoV-2 nucleic acids was performed on samples collected April 1 using a laboratory-developed test with Food and Drug Administration (FDA) Emergency Use Authorization (EUA). The FDA EUA Cobas® SARS-CoV-2 test (Roche) was used for testing occurring on April 5 and 6. Both assays have 100% technical sensitivity for SARS-CoV-2 present at >5000 copies/mL and a clinical sensitivity in symptomatic hospitalized patients of >90% for nasopharyngeal swabs performed during the first 5 days after symptom onset (Miller et al., unpublished data).

For detection of SARS-CoV-2 specific IgM and IgG antibodies we used a commercial lateral flow assay (Biomedomics, Jiangsu Medomics, China) validated and deployed as a high-complexity molecular test (EUA submitted). The test has a sensitivity of >90% in samples drawn >12 days after symptom onset and specificity for IgM and IgG of 99.47% and 99.74%, respectively.

Analyses

Statistical analysis consisted of Fisher's exact test for dichotomous variables or *t*-test for continuous variables. Data analysis was conducted using Stata (v13.0, StataCorp).

Results

Resident Testing

At the time of initial testing, average resident age was 83 (range 54-102, IQR 61-98) and 28% of the population was male. All residents were reportedly asymptomatic at the time of initial testing per daily symptom screening. Chronic respiratory illnesses were present in 20.6% of residents with available health records.

On April 1, 52 of 97 residents (53.6%) tested positive for SARS-CoV-2 by PCR. One sample with a high cycle threshold value may have been a false positive.

Significantly more patients on the memory unit tested positive (75.0%) compared to patients on the short-term (53.3%) and long-term (34.3%) care units ($p < 0.01$).

Residents who initially tested negative (45) were retested on April 5, with 31 (69%) now testing positive for SARS-CoV-2. One previously positive patient was inadvertently re-tested and remained positive. The suspected false positive result now tested negative. In sum, 85% of the 97 residents at the facility tested positive for SARS-CoV-2. The mean cycle threshold value for residents tested on April 5 (20.8, 95%CI 19.0-22.6) was significantly lower than for those tested on April 1 (23.3, 95%CI 21.3-25.3) ($p < 0.05$). Three residents transferred into the facility in the two

weeks prior to April 1 all tested positive, with mean cycle threshold values of 41.1, 29.1 and 20.4.

A total of 56 (58%) residents underwent serologic testing, with 45 (80%) negative for both IgM and IgG. One resident testing positive for IgM and negative for IgG was negative by PCR on both dates. No significant differences were found in antibody profiles between those initially testing negative by PCR and those testing positive (Figure 1).

In the 2 weeks following initial testing, a total of 30 residents (30.9%) died, with 24 (80%) occurring in those testing positive for SARS-CoV-2.

Staff Testing

On April 6, 97 staff members (66% of total facility staff, average age 45) were tested; 36 (37.1%) were positive for SARS-CoV-2. Mean cycle threshold was not significantly different than the resident cohort (22.4, 95%CI 20.9-23.9). Eighty (95.2%) of 84 staff tested for antibodies were negative for both IgM and IgG. One staff member testing positive for both IgM and IgG was negative by PCR.

Discussion

Asymptomatic and presymptomatic transmission of SARS-CoV-2 has been well reported [4, 7-9]. However, large scale testing of asymptomatic populations is still not regular practice. Our results affirm that SARS-CoV-2 may be widely present in congregate settings even in the absence of known symptomatic individuals [10-12]. In this single site evaluation of a reportedly asymptomatic population, we found an initial point prevalence of SARS-CoV-2 of 53% in residents, rising to 85% in residents and almost 40% in tested staff just 4 days later. This is consistent with previous studies that reported similarly high rates of asymptomatic and presymptomatic infection in residents of nursing homes and congregate care facilities [3, 4, 10].

Importantly, this facility had a strict visitation and patient and staff screening policy, including daily symptom and temperature checks, in place prior to our evaluation [13]. Additionally, infection control policies in place for at least two weeks prior to testing included universal masking for all staff and increased attention to hand hygiene. Masking was also required for any resident leaving their room. Admissions were heavily restricted, with only 3 patients transferred into the facility in the two weeks prior to our testing. Further, after our initial testing revealed a high prevalence of SARS-CoV-2, aggressive measures were taken to cohort positive patients.

Multiple explanations exist for this concerning rate of infection. Despite social distancing policies, residents continued to intermingle due to difficulty restricting patient movements. This was a particular challenge in the memory unit, likely contributing to a significantly higher prevalence of disease. It is also possible that there were undetected cases whose symptoms were attributed to chronic respiratory illness.

Alarming, almost 40% of tested staff were positive. One staff member testing negative by PCR tested positive for both IgM and IgG suggesting a convalescent infection. Staff are a known vector for transmission [3] and it is possible that infection was spread, and perhaps introduced, via staff. Staff may have been disincentivized to report symptoms due to fears of work loss, and staff working multiple jobs may have facilitated spread of infection between facilities. Further, insufficient training in appropriate PPE technique may have contributed. While appropriate PPE policies were in place, adherence cannot be confirmed. A national CMS survey the week before our evaluation found that 36% of nursing homes did not follow hand washing guidelines and 25% failed to demonstrate proper PPE use [6].

There was little antibody development in both populations despite relatively high viral loads, suggesting we assessed patients early in their infection and possibly before the onset of appreciable symptoms. Currently, little is known about the clinical sensitivity of serologic testing in asymptomatic or presymptomatic populations with acute infection and precise performance characteristics are limited. However, it appears serologic testing in the early stages of an outbreak is of limited use.

Limitations

Our findings from a single facility may not be generalizable, though similar findings have been reported [4, 10]. Further, clinical data including causes of death were limited. While the population under investigation was reportedly asymptomatic, this is challenging to verify. Many of the residents were cognitively impaired or had baseline respiratory conditions, which may have led to unrecognized symptoms. Early in the pandemic,

access to testing was limited and mandatory testing of staff could not be conducted. Only 66% of the staff opted for voluntary testing and our estimate of disease prevalence in staff may therefore be an overestimate if concerned staff preferentially agreed to testing or an underestimate if some staff members were unavailable on the day of testing.

Conclusions

Congregate care facilities must take strict precautions once COVID-19 is documented in a community. Intensive infection prevention interventions including use of PPE are essential [14], but may be insufficient. Widespread testing among nursing home residents must be implemented and staff must be included in testing to identify cases early and avoid staff transmission [11, 12]. Until preventative and curative therapies become available, increased testing, meticulous infection control, and advance care planning are essential in caring for this vulnerable population. Simply screening for symptoms is no longer enough.

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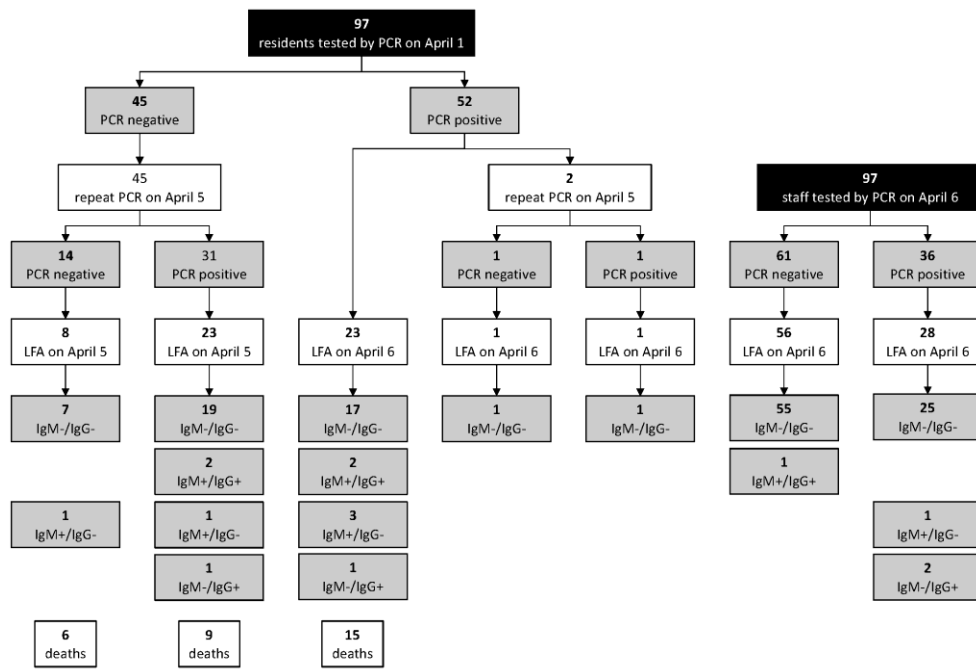
Figure 1. Flow diagram for PCR and serology testing of residents and staff

LFA = Lateral flow assay, PCR = Polymerase chain reaction

Figure demonstrating number of residents and staff testing positive or negative for SARS-CoV-2 by PCR at varying time points, and the serologic results for those with blood samples available for LFA analysis.

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Figure 1



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