enviral tech

White Paper

Protecting Long-Term Care Communities Through COVID-19 Surface Testing

Findings of a 5-week study in 52 long-term care Communities in the US

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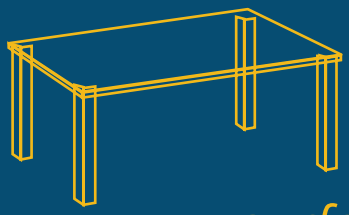
Summary

Since March, long-term care communities and nursing homes in the U.S. have faced an unprecedented challenge. COVID-19 has deeply impacted all aspects of American life, but no sector has been affected like long-term care. Over 45% of all domestic COVID-19 fatalities have taken place in long-term care setting. The response to the outbreak has been complicated by a lack of personal protective equipment and sufficient human testing resources. The high rate of asymptomatic spreaders of the disease makes screening programs ineffective. More than half of carriers shedding virus and infecting others have no symptoms whatsoever. Surface testing for virus has been used for over a decade, and has been brought to bear in the COVID-19 epidemic in acute care settings. This study used surface testing in 52 long-term care facilities over a 5-week period to determine if outbreaks can be detected earlier by monitoring the environment for the presence of the SARS-CoV-2 virus and to understand how the virus is distributed on indoor surfaces. Over 2,600 individual samples were tested taken from over 600 surfaces. In the study, 18 facilities showed virus on a combined total of 55 surfaces. The overall rate of positive tests was 2.46%. Four outbreaks were detected, one a full week before any other method would have provided warning.

Study parameters

6
States



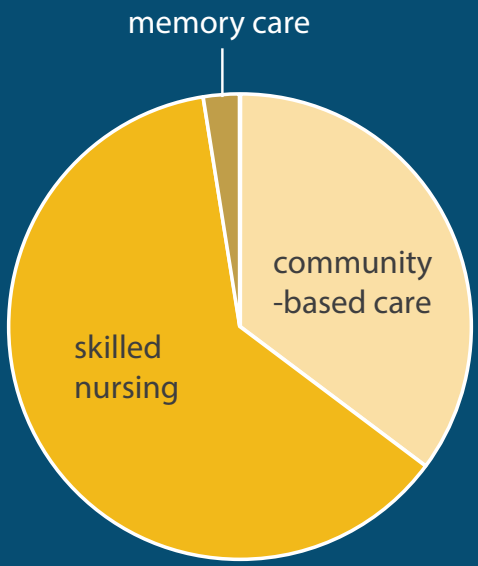
625
surfaces Tested

52 *Facilities*

5
Weeks

2605
Samples

Type of facilities tested



Workflow

All samples were collected by staff members of the tested facilities and shipped overnight to Enviral Tech's lab. Results were delivered within 12-24 hours of arrival to the lab. Each facility was asked to select 8 surfaces according to guidelines consistent with the CDC recommendations (high-touch surfaces such as doorknobs, railings and computer peripherals) and swab them 2 times each week.

Study results

18/51 *facilities*

with COVID-19 positive surfaces. All proceeded with human testing within their community.

90% *early detection of outbreak*

When testing 8 surfaces weekly.

Top 5 most commonly COVID-positive surfaces

Reliable early outbreak warning

In facilities w/ COVID-positive Surfaces

Of 6 facilities showing COVID-19 on surfaces but not reporting any human positives at survey time (white), at least 2 reported a later outbreak in the human population. In at least 1 of these facilities, the COVID-positive surface was in the lobby, where outsiders are present daily.

Human tests negative or not performed, no symptoms

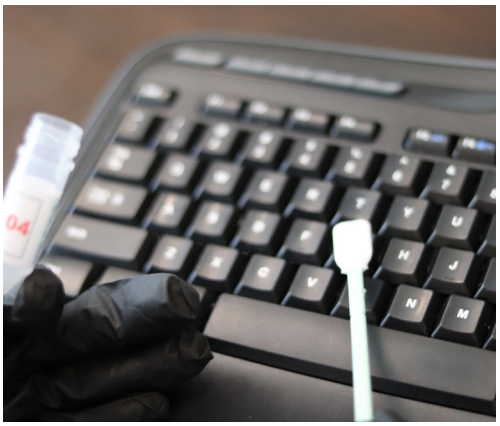
Outbreak: Positive human tests and/or symptoms

In facilities w/ COVID-negative Surface test(s)

Several of the facilities that showed positive human tests but no positive surfaces (red), describe that COVID-positive staff members actually did not enter the facilities after symptoms appeared and they tested positive.

Introduction

As a research tool, viral surface testing has been used since 2002 [1] and has been applied to coronaviruses as early as 2004 [2], in the wake of the first SARS epidemic. In the present outbreak, real-time polymerase chain reaction (RT-PCR) surface testing has been used in hospital environments to study the distribution of virus in COVID-19 wards [3]. The CDC and WHO both acknowledge the value of surface testing as a tool in the arsenal to fight COVID-19. However, to date there has been no study seeking to evaluate surface testing as a surveillance tool to get early warning of viral outbreak in the environment of a vulnerable population.



Study design

We recruited 52 long-term care facilities belonging to 3 different networks in 6 different U.S. States to participate in a COVID-19 surface testing study. The facilities included some known to have active COVID-19 cases, but the majority were facilities with no known prior or present COVID-19 presence. Community-based care, Skilled Nursing and Memory Care facilities were represented in the study. Each facility was asked to select 8 surfaces according to guidelines consistent with the CDC recommendations (high-touch surfaces such as doorknobs, railings and computer peripherals) and swab them 2 times each week. The samples were shipped overnight to a central facility (Enviral Tech,

Figure 1. A) The provided testing kit, including pre-wetted sampling swabs, pre-filled vials containing viral transport medium, disposable gloves to be worn during sampling, a data card to record the locations and times of sample collection, and a biohazard containment bag for return shipping of the samples. B-C) Shows an operator taking a surface sample from a computer peripheral device.

Inc., Eugene, OR), and processed within 24 hours of receipt using an FDA/EUA approved diagnostic kit (BGI 2020) adapted for use in environmental testing. Samples were collected between 11 May 2020 and 12 June 2020. Sampling was performed onsite by facility staff using instructions included in the surface sampling kit provided. Each kit comprises 4 swabs, so each facility used 2 kits each day they collected samples. In brief, participants swabbed surfaces using pre-wetted synthetic fiber swabs, placed the swab into a vial pre-filled with viral transport medium (VTM), sealed the vials in the provided biohazard containment bag and shipped the samples via overnight courier to the testing laboratory. In the laboratory, each kit was first pooled for screening. A portion of the VTM from each vial was mixed together into a single pool and tested using a single-target COVID-19 test provided by MGI America (San Jose, CA). If the pool tested negative, all four swabs were called negative. If the pool tested either positive or inconclusive (showing signs of COVID-19, but below the official limit of detection), each of the swabs was re-tested individually (Fig. 3).

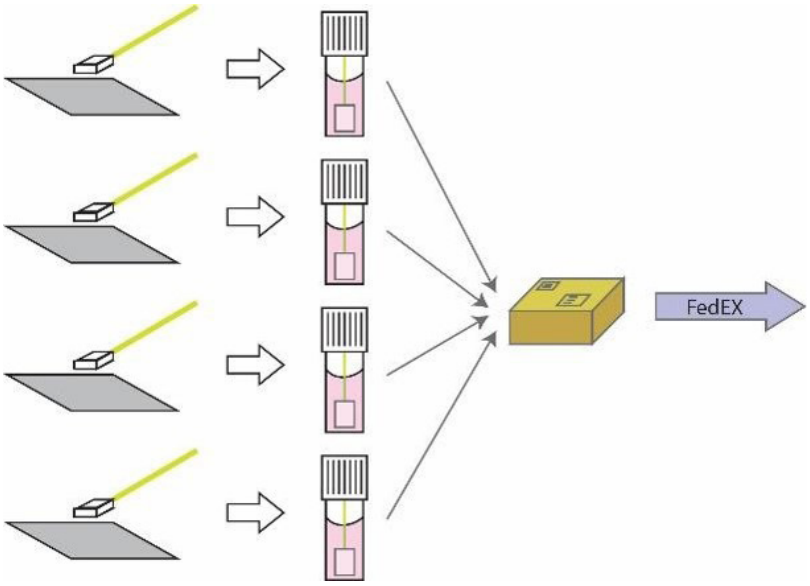


Figure 2. Sampling process. Each kit contains 4 swabs and 4 vials. The facilities used 2 kits per sampling day.

Results were reported back to the facilities within 24 hours of receipt of the samples at the testing laboratory. An example results report is shown in Fig. 4.

At the beginning of the study, the facilities were surveyed to gather information related to cleaning protocols, human testing criteria, number of human tests conducted, and the number of COVID-19-positive tests as of the time of commencement of the study. No individual patient information was collected.

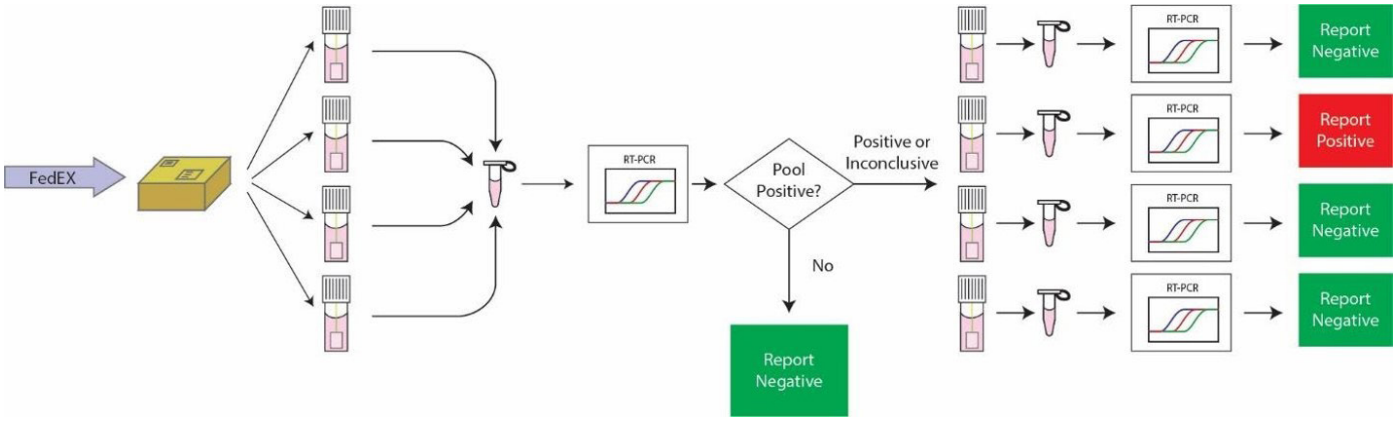


Figure 3. Sample processing. At the testing laboratory, a sample of the VTM was taken from each vial and pooled for initial screening. If the pool showed no virus present, all four samples were called "negative". If the pool tested positive or inconclusive, each of the 4 vials were re-sampled and tested separately.

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Surface Testing – SARS-CoV-2 Report

Last updated:	7/9/2020			
Building Information		**Company Name**		
		Facility Name		
Sample Name	**Sample Information**	**Collection Date**	**Test Date**	**COVID-19 Results**
20128AC01289-1	AL MED ROOM	-	9-Jul-2020	Negative
20128AC01289-2	AL ELEVATOR BUTTON	-	9-Jul-2020	Borderline
20128AC01289-3	MC MED ROOM	-	9-Jul-2020	Negative
20128AC01289-4	MC COMMON AREA CHAIR	-	9-Jul-2020	Negative
20128AC01289	AL MED ROOM AL ELEVATOR BUTTON MC MED ROOM MC COMMON AREA CHAIR	-	8-Jul-2020	Inconclusive
20128AC01290	ADMIN EMPLOYEE TIME CARD AREA FULL COUNT SCREEN B WING ELEVATOR BUTTON ADMIN DOOR HANDLE	-	8-Jul-2020	Negative
20128AC01167-1	4TH FLOOR SITTING AREA LIBRARY	7/2/20	5-Jul-2020	Negative
20128AC01167-2	2ND RESIDENT RELATIONS DOOR	7/2/20	5-Jul-2020	Negative
20128AC01167-3	1ST CONCIERGE COUNTER	7/2/20	5-Jul-2020	Negative
20128AC01167-4	1ST FLOOR EMPLOYEE TEMP BREAKROOM	7/2/20	5-Jul-2020	Negative
20128AC01167	4TH FLOOR SITTING AREA LIBRARY 2ND RESIDENT RELATIONS DOOR 1ST CONCIERGE COUNTER 1ST FLOOR EMPLOYEE TEMP BREAKROOM	7/2/20	3-Jul-2020	Inconclusive
20128AC01168	AL MED ROOM	7/2/20	3-Jul-2020	Negative

1

Figure 4. Example COVID-19 Surface Check report. During the study period, each facility was provided a report on the results of the testing they performed. The report includes the notations made by the facility staff as to the identity of the surfaces tested and the associated test result. A sample known to contain a molecule ubiquitous in all human-occupied environments was used in parallel to the facilities' samples, as a control to ensure that the swabbing was successful and that the PCR test operated as expected.

Facility staff report that surface testing gave them up to a week of advance notice of outbreaks.

Results

Surfaces tested

The surface selections reported by the facilities were manually classified to allow quantification of the occurrence of virus according to each type of surface. The selections made by the 52 facilities are shown in aggregate in Fig. 5. Notable results in looking at the types of surfaces that led to positive results include service carts of various types. On interviewing facility staff, it was noted in several cases that service carts had been excluded from regular disinfection protocols because they were stowed at the time of cleaning. The study results led to changes in cleaning protocols in this instance and many others. In other studies (Wuhan 2020) air-vents were a frequent source of positive swabs. However, in this study the number of air-vents selected by facility staff (two) was too small to provide a significant conclusion.

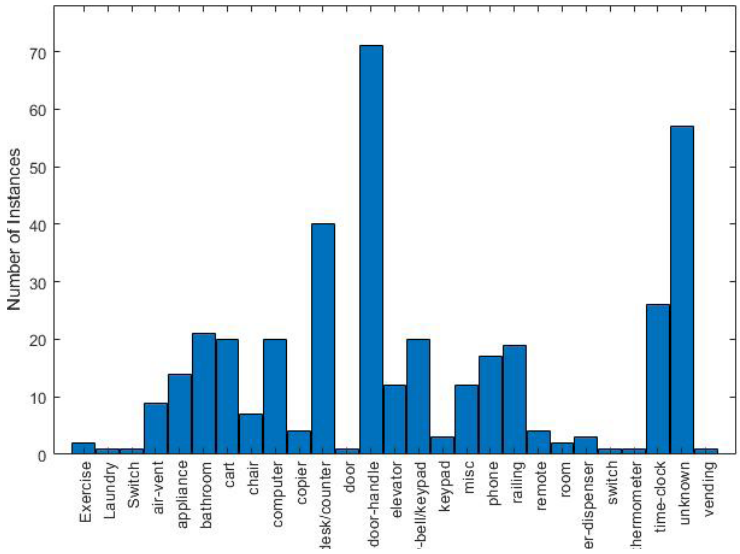


Figure 5. Numbers of surfaces tested by type. Frequently tested surfaces include door handles, desk or counter surfaces, entry keypads, elevator call buttons and handrails. When no information was provided by the facility, the surface was classified as "unknown".

The study gave insight to the rates of false negatives and false positives. While no gold-standard comparator is available for this study (RT-PCR is used as the reference test for virus presence), we can use the replicate testing inherent in the structure of the study (pools first and breakouts second) as a means of checking for internal consistency. In the study, out of 652 pools tested,

The operators noted that the surface testing is more cost-effective than 100% staff and resident testing protocols, and that the criteria used to initiate human testing based on screening questions or measuring fever miss more than half of all infectious cases.

there were just three inconsistencies (twelve swabs), meaning that the pool tested positive, but all 4 swabs individually tested negative. If we assume all three of these were false positives in the pool, this would represent a false positive rate of 0.5%. If instead, we assume that in each of these 3 cases, all twelve of the negative swab results were wrong, this would represent a false negative rate of 15%. This compares favorably with the 20% false negative rate that is routinely seen for human testing.

The study data also allow estimation of how well a single surface represents a facility in the case of an outbreak. If we treat the surfaces selected as being independent of each other, we can estimate that a single surface in a facility having an outbreak will have about a 25% chance of testing positive. In the case that swabs are independent of each other (meaning far enough apart that they are representing different aspects of the facility), that 4 swabs would lead to a 70% chance of seeing an outbreak in progress, and 8 swabs would give a 90% of detection. These models don't take into consideration that different outbreaks will have different sizes and degrees of contamination. Smaller outbreaks will be missed more often, and larger outbreaks will be detected more often.

Fifty-one of the facilities responded to surveys requesting information about, among other things, their human testing status. A comparison of the presence of virus found with human testing with virus found using surface testing is shown in Fig. 9.

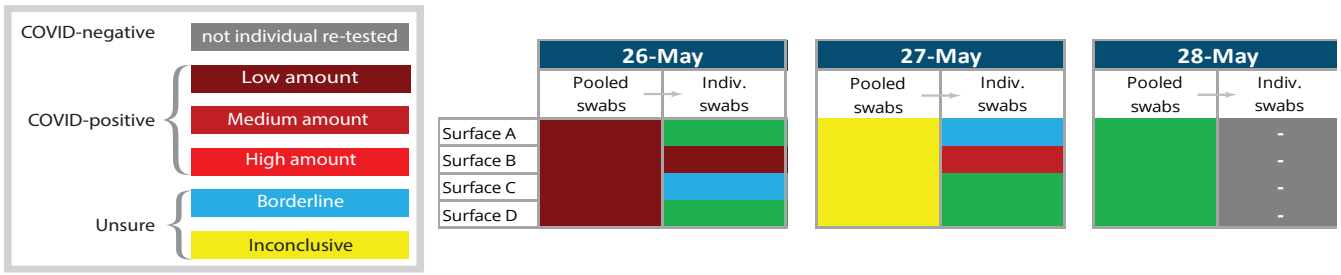


Figure 6. Tableau of Results. The results were collected into a tableau, with each row representing an individual surface, such as a specific doorknob, or handrail. The columns represent the progression of time, with each day being represented by a column to represent pooled tests, and a separate column to represent breakout tests (samples tested individually rather than pooled) when they were conducted. This is an excerpt of the tableau showing the colors codes used for the various calls ("Negative", "No Test", "Inconclusive", "Borderline", "Positive-Low", "Positive-Medium", and "Positive-High"). Breakout testing of individual swabs were conducted for all samples that were not "Negative".

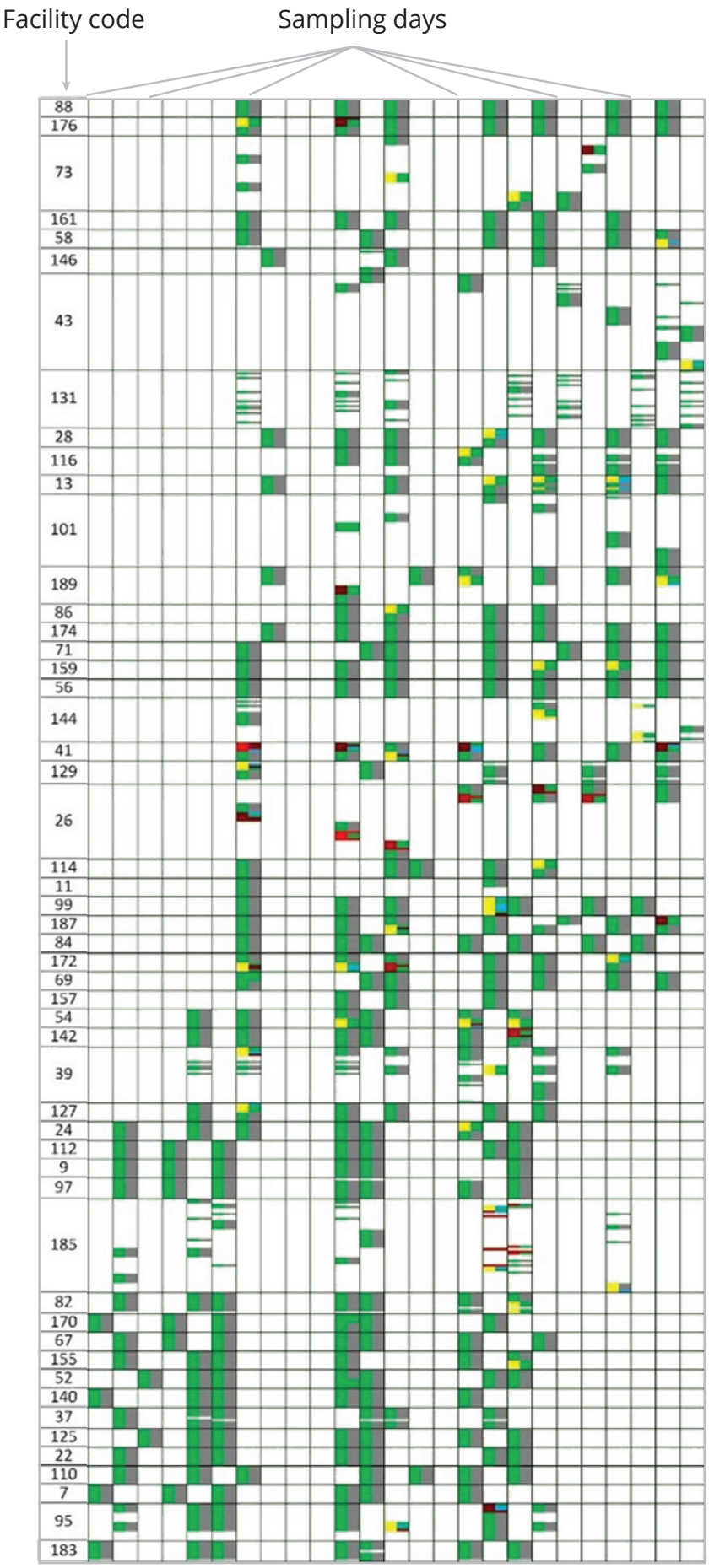
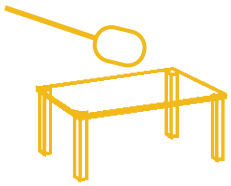


Figure 7. Tableau of results for all testd facilities for the first 26 days of the study. Each facility was given a pseudorandom identifier code (left column). A majority of facilities hqad no COVID-positive results while other facilities had numerous instances of COVID-positive surfaces. The starting and end date on each of the facilities was slightly different, which is illustrated by the staggered appearence of the first columns.

Study Parameters	Number	Rate
Facilities	52	
Facilities with Positive COVID-19 Surfaces	18	35%
Total Surfaces	625	
Positive Surfaces	55	8.40%
Total Swabs Tested	2605	
Positive Swabs	64	2.46%

Figure 8. Summary of results for the entire study.

Figure 9. The agreement between human testing and surface testing. 51 of the 52 facilities responded to a survey inquiring about COVID-19 testing in the staff and resident population as of the time of the survey (which varied from 3 days post-start to 14 days post-start). We observe strong evidence of concordance between surface and human testing results (P ~ 0.0023). Of 6 facilities showing COVID-19 on surfaces but not reporting any human positives at survey time, at least 2 reported a later outbreak in the human population. In at least of these facilities, the lone positive test was in the lobby, where outsiders are present daily. In the facilities that showed positive human tests but no positive surfaces, several of these describe that staff members fell ill and tested positive, all without ever entering the facility.



	Positive	Negative
Positive	26	7
Negative	6	12

	Surfaces	Positives	Expected	P-value	Factor
CBC	389	24	34.85	0.001611 *	0.69
MC	16	3	1.43	0.165629	2.09
SNF	220	29	19.71	0.005689 *	1.47
Total	625	56	56	N/A	1

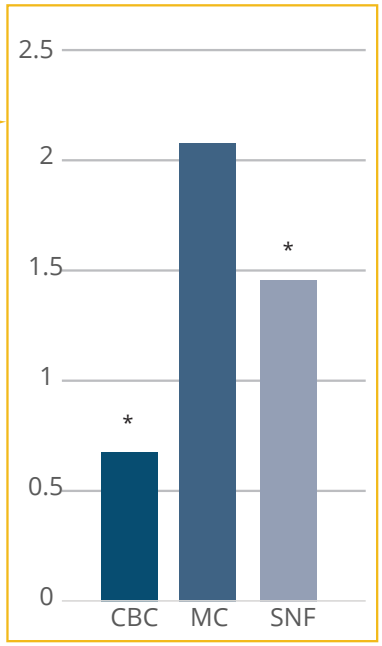


Figure 10. Distribution of positive results according to facility type. COVID-19-positive surfaces from community-base centers (CBC) are significantly underrepresented while COVID-positive surfaces from skilled nursing facilities (SNF) are significant overrepresented. This data suggests that NSF may be more susceptible to COVID-19 outbreaks compared to CBCs. The likely explanation is that asymptomatic carriers on the facility staff are the main route of entry for the virus, and SNF and MC have higher staff-to-resident ratios because of the higher acuity of care. Memory care (MC) facilities had the highest rate of positive results, but there were too few of them to give statistical significance.

In several cases [...] service carts had been excluded from regular disinfection protocols because they were stowed at the time of cleaning. The study results led to changes in cleaning protocols.

Detection of Outbreaks

In several instances surface testing showed the presence of virus either before any other sign was seen, or simultaneous with the emergence of positive human tests. Fig. 11 shows two such occurrences. Facility staff report that surface testing gave them up to a week of advance notice of outbreaks. The operators noted that the surface testing is more cost-effective than 100% staff and resident testing protocols, and that the criteria used to initiate human testing based on screening questions or measuring fever miss more than half of all infectious cases.

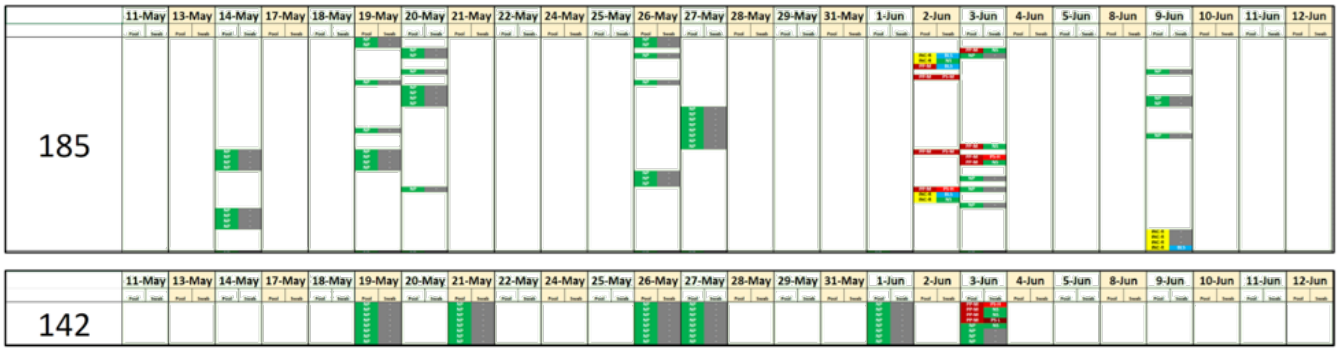


Figure 11. Two example outbreaks detected. Both facility 185 and facility 142 were ostensibly free of COVID-19 at the start of the study. In the case of facility 185, there were no indications of viral presence when swabs were taken on June 2nd. When multiple positive results were reported back to the facility (on June 3rd) the facility staff took note that the virus had been found on the staff time clock device. In response to this, they tested every employee and quickly identified that an asymptomatic carrier had brought the virus into the facility. They isolated that employee and thoroughly cleaned the facility. That employee did not develop any symptoms until 1 week later, at which point the number of infected individuals could have grown significantly and could even have initiated secondary infections. In facility 142, they received a positive human test and positive surface tests on the same day, June 4th. In this case, an employee had fallen ill the day before, and both the human test and the surface test identified the outbreak simultaneously.

Conclusions

Surface testing provides an affordable and sensitive means to detect outbreaks in long-term care communities earlier than will sometimes be detected using existing screening and human testing protocols. All three companies participating in the study elected to continue with routine surface testing, reporting that these tests bring them a positive ROI. The testing contributed to changes in cleaning protocols in more than half the facilities. The data indicate that surface testing can be a sensitive and accurate means of observing when COVID-19 has entered a facility. The use of environmental surfaces as sentinels of viral presence allows cost-reduction by aggregating the effect of many people in a single test. The detection of the virus in surfaces avoids compliance issues related to consent and privacy: once the virus enters the environment, it is an aspect of the facility, not an individual person.

References

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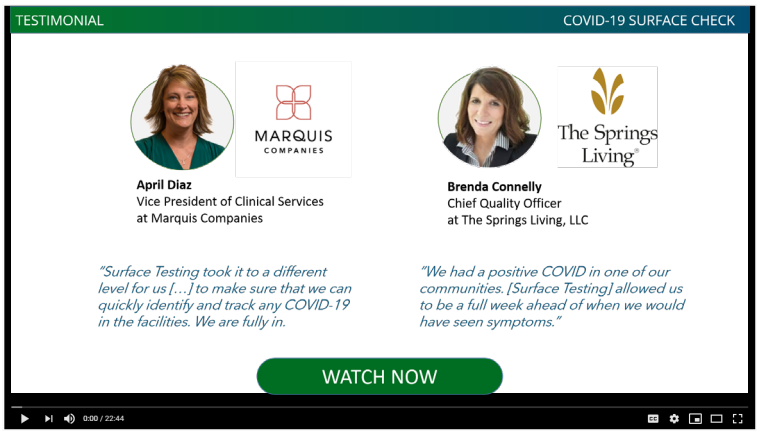
3. **Aerosol and Surface Transmission Potential of SARS-CoV-2**. Joshua L Santarpia, Danielle N Rivera, Vicki Herrera, M. Jane Morwitzer, Hannah Creager, George W. Santarpia, Kevin K Crown, David Brett-Major, Elizabeth Schnaubelt, M. Jana Broadhurst, James V. Lawler, St. Patrick Reid, John J. Lowe. doi: https://doi.org/10.1101/2020.03.23.20039446

Additional information



Hear from participants to this study.

Discover how using COVID-19 Surface Testing, these LTCs have successfully contained outbreaks.

https://enviraltech.com/video-library/LTC-Testimonials

Enviral Tech is responding to a surge of requests from concerned Long Term Care Community managers who want to ensure that their community is safe. They want to detect the COVID-19 virus SARS-CoV-2 in the environment either after suspicion of a contaminated patient having been in the facility or to confirm the effectiveness of their cleaning.

Find the COVID-19 virus as soon as it is brought into your facility and prevent or take early control of outbreaks.

https://enviraltech.com/solutions-for-elder-care-facilities/

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