TITLE: Pooled Nucleic Acid Testing to Screen Laboratory Workers for Novel Coronavirus Infection

AUTHORS

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ABSTRACT

Closing workplaces to protect workers from infection by the novel severe acute respiratory coronavirus (SARS-CoV-2) has dramatically affected our economy and also research activities. Together with protective measures, serial testing could help provide a safe working environment. We evaluated a pooled nucleic acid testing (NAT) strategy in a research laboratory in San Diego, California after a worker was identified with a household contact who was infected with SARS-CoV-2. Nasal swabs were collected from laboratory employees on the day their co-worker disclosed they had a household infection, including the index technician. Over the 5-week study period, we serially screened 19 laboratory employees after their potential laboratory exposure. This systematic approach allowed the laboratory to maintain its research activity and saved an estimated 1,020 person-work hours and $63,450, which would have otherwise been lost due to quarantine of employees.

INTRODUCTION

Many businesses across the United States (US) have temporarily closed down to help reduce surges in hospitalizations[1]. As the US economy restarts, methods must be developed to protect employees in the workplace. This includes biomedical laboratories working on SARS-CoV-2, as one infected employee could cause the entire lab to be shutdown for weeks. This is because all employees in contact with the index case may need to be quarantined for at least two weeks. Such quarantining after potential exposure can also reduce workforce capacity in essential service settings, like hospitals, clinics, police, and fire departments. Regular screening could theoretically decrease the risk of workplace infections, but individual tests are in short supply, costly and not always performed in real time to ascertain asymptomatic infections and thus infectiousness.

This study evaluated pooled nucleic acid testing (NAT) strategies to screen for SARS-CoV-2 infection in laboratory employees. Such pooled NAT strategies have been used for screening for acute HIV across communities[2] and in blood donors for HIV and HCV[3]. This pooled NAT strategy was implemented in a new point-of-care, low complexity NAT platform (FluxErgy Inc., Irvine, CA).

METHODS

This study was conducted under a protocol for collecting samples from persons with known or possible SARS-CoV-2 infection in accordance with relevant guidelines and regulations and approved by the Institutional Review Board of the University of California San Diego (UCSD) and written informed consent was obtained from all participants involved in the study. Laboratory employees had the option of self-quaratining at home or continuing to work, per UCSD employee health guidelines. If they chose to come to work, then they were offered participation into the study. If they decided to participate in the study, they could also could choose to perform their own anterior nasal swab (self-swabbing) or having an anterior nasal swab collected by an on-site physician.

The study took place in an academic virology laboratory at UCSD. The Fluxergy platform was evaluated in the lab by comparing results with the RT-PCR Diagnostic Panel authorized for Emergency Use Authorization.[4] The limit of detection was also evaluated prior to the study and was estimated to be 2.4 copies/μL (**supplementary materials**). Swabbing was offered to all laboratory research personnel between April 9 and May 8, 2020. The sampling and testing protocol was designed as follows (**Figure 1**).

1. Nasal swabs were collected on a daily basis for all eligible participants at the beginning of their respective shift, (two daily shifts). Polyester flocked swabs were used in all nasal swabs (COPAN, Murrieta,CA).
2. After collection, the nasal swabs were placed in 3mL of viral transport media (VTM).
3. Equal volumes (14μL) of VTM from each participant in the same shift were combined into a one pool (‘mini-pool’). The remaining VTM was stored individually for subsequent testing should the pool require deconvoluting.

4. Each minipool underwent testing in the FluxErgy platform (Irvine, California, USA), which is currently available as a Research Use Only (RUO), or Investigational Use Only (IUO) device for the development of new diagnostic products. This platform was chosen because of its quick turnaround time and simplicity of use.
5. If a minipool test was positive, all samples from that pool were tested individually.
6. Experimental pools were also evaluated to determine how many samples could be pooled together to identify a positive nasal swab in the pool.

RESULTS

On Day 1 (April 9th), a laboratory technician reported that a member of their household tested positive for SARS-CoV-2 infection. This index case was asymptomatic at the time. All seven members of the laboratory at work that day, including the index case, volunteered for screening for SARS-CoV-2 infection by individual and pooled NAT. The minipool of 7 nasal swab samples was found to be positive within an hour of swabbing, and individual testing of each specimen confirmed positivity for only one sample while a minipool of 6 without the index case was negative. The index case was sent home to follow-up with their primary care provider and for self-isolation.

On Days 2-29, eigtheen laboratory employees volunteered for screening, and were screened depending on their work schedule. Nasal swabs were batched in minipools of 7 samples on average [range 3-12] and tested for SARS-CoV-2 at the beginning of each work shift, i.e. twice a day. All these minipool tests were negative (**Supplementary Tables S1 and S2**). A total 171 NS from 19 participants were collected over the study period. On Day 16, the index employee, who had remained asymptomatic during their isolation, returned to work and was tested by individual NAT. The employee's test was negative and they resumed work.

Swabbing and preparation of each minipool was routinely accomplished in less than 30 minutes. Results were available approximately 1 hour after the minipool was loaded on the Fluxergy platform. Thus, most employees were aware that the minipool was negative within 90 minutes of arrival.

Pooled NAT validation

To evaluate the sensitivity of the pooling strategy, we additionally performed an experimental pooling of 30 stored samples collected during the study period, including one sample from the index case. Evaluation of pool sizes found that this positive sample from the index case could be detected up to a pool size of 30 samples.

Cost estimates and budget impact

Current cost per assay, including technician time, is $75/assay, so the cost of screening 19 participants with 31 batches and 7 individual confirmation tests was $2,850. Since testing is not widely available, the CDC currently

recommends that all potentially exposed persons self-quarantine for 14 days[5], thus 1,020 hours of laboratory work would have been lost, i.e. 18 employees over 170 shifts and a conservative average of 6 hours of work per shift. Since the average laboratory employee is paid $65/hour, the estimated costs saved by the pooled screening would have been $63,450 for the five weeks (i.e. $66,300 in salary minus $2,850 in testing costs).

DISCUSSION

As the world's economies seek to re-open and reduce shelter-in-place measures, testing for asymptomatic and presymptomatic carriers will be a critical step for employees in the workplace[6]. Testing, however, can be cost-prohibitive, especially when used for frequent screening of a population with low incidence of infection. For this reason, pooling of samples from all persons who will be working together, can provide a sensitive and cost-efficient method of detecting virus shedding within a work environment. This study found that, in an academic virology laboratory, pooled NAT was acceptable to laboratory employees, and that it could save over $63,000 in laboratory wages.

Based on this small study, true risk reduction in workplace infection could not be ascertained or generalized to other settings. Further, while the FluxErgy platform was used in this study, other NAT platforms could also be used, but their test characteristics would need to be evaluated.

With current testing supplies limited, pooling of samples from persons who work together or are otherwise in close proximity offers a cost-efficient way to increase the surveillance of a population while enabling progressive deconfinement. In a real work, prospective setting, this study validated a fast, sensitive, and efficient platform for routine testing of SARS-CoV-2 infection. This approach could be applied in other settings to help ensure safe return to work procedures. It could be envisioned in high-risk settings such as screening of all healthcare workers in a cancer or HIV clinic or nursing home, or screening essential personnel in police or fire departments.

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Author Contributions

SAR performed study procedures, analyzed data, and reviewed the manuscript. BS, LL, MP, and CI performed study procedures and reviewed the manuscript. PN, RH, and SG analyzed data and reviewed the manuscript. AC and DS analyzed data and wrote the manuscript.

TABLES AND FIGURES

Figure 1. Study schematic. 1. Nasal swabbing was offered to all laboratory research personnel between April 9 and 24, 2020; **2.** Nasal swab (NS) were collected on a daily basis for all eligible participants (ideally at the beginning of their shift); **3.** After collection, the NS was placed in viral transport media (VTM); **4.** VTM of all participants from the same shift were combined into a one pool ('mini-pool'); **5.** Each minipool underwent testing in the FluxErgy 1 hour platform; **6.** If a minipool test was positive, all samples from individuals who provided NS samples for that pool were tested individually (**7**).

SUPPLEMENTARY MATERIAL

Supplementary Table S1. Study Population and Testing Characteristics

Supplementary Table S2. Summary of the pools performed.

Supplementary Table S3. Comparative results of Fluxergy and SARS-CoV-2 Real-Time RT-PCR Diagnostic Panel.

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