

## SHORT COMMUNICATION

# Strategies and Experiences of the Small Laboratory to Cope with the Mass Nucleic Acid Test of SARS-CoV-2

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### SUMMARY

**Background:** The COVID-19 outbreak, which began in late 2019, continues to ravage the globe and has become the greatest threat to human health. As nucleic acid test is the primary means of screening for COVID-19, this makes the laboratory the most important node in the epidemic prevention and control system.

**Methods:** As a small laboratory in the hospital, we can meet a large number of demands for nucleic acid test by optimizing staff process, strictly disinfecting experimental batches and changing experimental methods.

**Results:** Through the improvement of the above aspects, our daily maximum detection quantity has been increased from 256/day to 1,012/day. Besides, none of the medical staff has been infected. And there have been no nosocomial infections.

**Conclusions:** Nucleic acid laboratories, especially small laboratories, should promptly adjust their strategies in the face of unexpected outbreaks and conduct risk assessment in accordance with laboratory activities.

(Clin. Lab. 2021;67:xx-xx. DOI: 10.7754/Clin.Lab.2020.200658)

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#### KEY WORDS

nucleic acid test, COVID-19, medical laboratory, testing capability

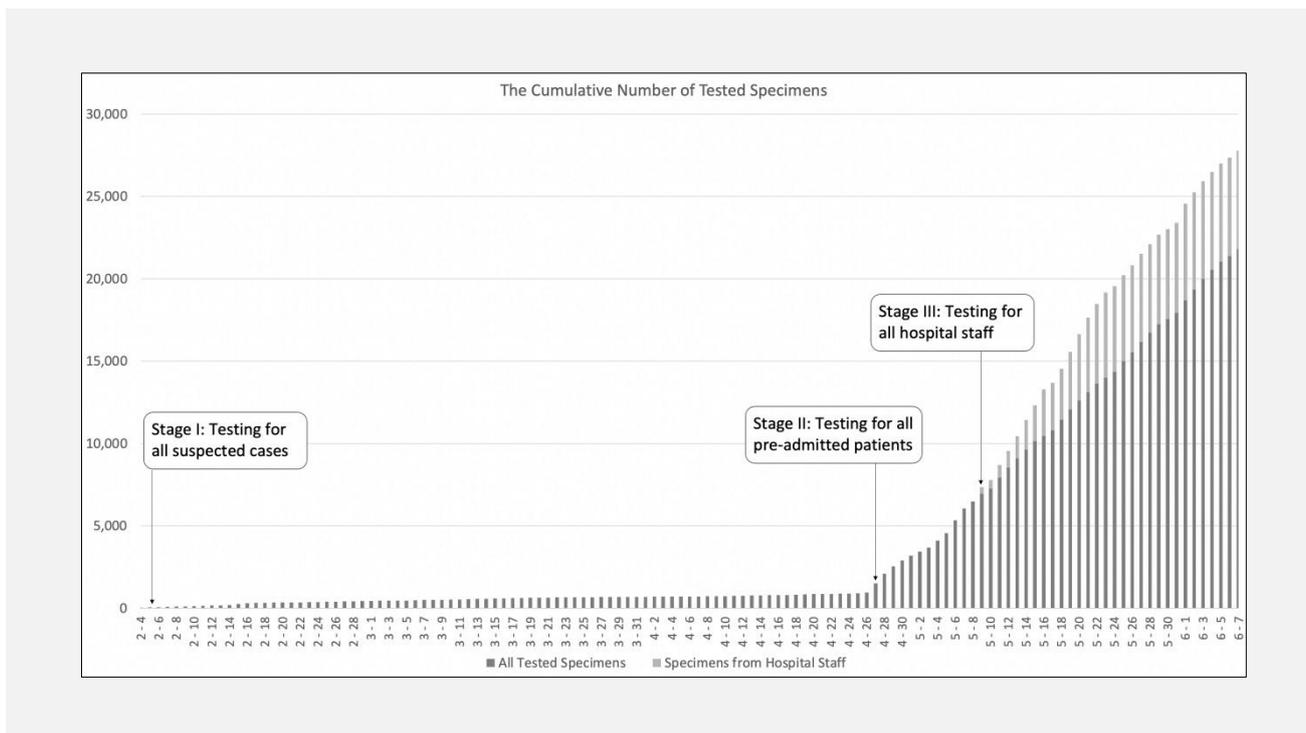
#### INTRODUCTION

As COVID-19 continues to rage around the world [1], it is a challenge to the laboratory's capacity. Since January 31, 2020, Qingdao Municipal Hospital became one of the designated hospitals for COVID-19 screening, the Nucleic Acid Test (NAT) laboratory of Qingdao Municipal Hospital has become one part of the screening system for COVID-19 in patients with fever and suspected cases [2,3].

The NAT Laboratory is specially established for the detection of novel coronavirus nucleic acid, which officially started operation on February 4, 2020. It has nine staff, including two administrators and seven laboratory doctors. With two Applied Biosystems Quant Studio 5

**Table 1. Characteristics of three stages of NAT laboratory in Qingdao Municipal Hospital. Updated June 7, 2020.**

Stages	Date	Total number of test specimens	Average number of test specimens (per day)	Main source of specimens
I	February 4 - April 26	952	11.5	suspected cases
II	Started on April 27	5,539	461.6	pre-admission patients
III	Started on May 9	21,287	709.6	hospital employees, pre-admission patients



**Figure 1. The cumulative number of tested specimens of the NAT laboratory of Qingdao Municipal Hospital.**

(Thermo Fisher Scientific Inc., Waltham, MA, USA) and one Applied Biosystems Quant Studio 3 (Thermo Fisher Scientific Inc., Waltham, MA, USA), the NAT laboratory had completed a total of 27,778 tests by June 7, 2020 (Figure 1).

As the epidemic in China continues to change, the NAT laboratory workload can be divided into three stages: i. Testing for all suspected cases, ii. Testing for all pre-admitted patients, and iii. Testing for all hospital employees (Table 1).

**Strategies for different testing amounts**

When we were in Stage I, the number of daily samples was relatively small. The NAT laboratory carried out experiments twice a day, 9 a.m. and 3 p.m. This minimized the risk of infection. At the same time, it can ensure that the specimens submitted for inspection at each

time period can get the results as soon as possible. In Stage I, we applied these rules as follows:

- I. In Sample Preparation Room, experiments must be performed by two technicians at least. One for contamination, is responsible for taking specimens, uncapping, and centrifuging. One for sterility, is responsible for taking reagent and adding. In this way, cross-contamination between samples is avoided as much as possible. Besides, it also reduces the scope of environmental contamination to reduce the possibility of laboratory staff being infected.
- II. Setting three negative controls and one positive control in random tubes in each 96 plate, thus monitoring for cross-contamination between samples [4].
- III. At present, the novel coronavirus nucleic acid test kit mainly detects Open Reading Frame (ORF)



**Figure 2.** The UN2814 specimen transport box.

specific fragments ORF1ab, nucleocapsid (N) protein gene, and envelope (E) protein gene [5]. In our laboratory, the first two genes are tested. But when only a single gene was positive, resampling for the test will be performed. If the single gene is still positive after retesting, the result will be determined as positive.

As in Stage II, there has been a marked change in the epidemic in China. The focus of epidemic prevention has shifted to large-scale screening. Therefore, pre-admission patients were included in the test range. Moreover, in Stage III, all hospital employees, including canteen staff, security guards, cleaning staff, and medical staff, everyone who works in the hospital were included. Thus, it makes the hospital a “coronavirus-free” place to minimize nosocomial infection.

Due to the change of the test range, the number of daily specimens has increased significantly. The NAT laboratory has made adjustments to the workflow correspondingly as follows:

I. Applying a new nucleic acid amplification test kit (Hunan Shengxiang Biotechnology Co., Ltd, Changsha, Hunan, PRC) without RNA extraction for SARS-CoV-2. The specimens are nasopharyngeal swabs collected from patients and inactivated at 56°C for 30 minutes in a dry oven. We reduced the turnaround time (TAT) to 160 minutes per 92 samples. As we have 3 PCR instruments, the TAT of 276 samples can be reduced to 220 minutes.

II. Completing disinfection for each batch test. The following steps are performed:

- a. Disinfecting the pipettor with 75% alcohol, especially its front end.
- b. Disinfecting the countertops, safety laminated glass, and handles (if manual) of the biosafety cabinet (BSC).
- c. Wiping the workbench surface thoroughly and drawer pulls with a disinfecting paper towel.
- d. Disinfecting the floor with 1:100 chlorine solution.
- e. Turning on the blower and UV light of BSC for 60 minutes.
- f. Turn on the mobile UV-Light air purifier for room air sterilization for 60 minutes.

III. Rearranging the work shift into four hours per duty and four duties per day at most. In this way, the maximum testing capacity of the NAT laboratory has been increased to 1,104 cases per day.

#### **Measures to reduce contamination outside the laboratory**

A big challenge for highly pathogenic nucleic acid laboratories which are set up in hospitals is how to avoid hospital contamination. Our laboratory and the novel coronavirus specimen collection rooms are not in the same building. The specimen transportation path overlaps with public areas. According to these conditions, the NAT laboratory worked out the corresponding

countermeasures and finally formed a Risk Assessment Report (RAR). The RAR was approved by the Institution Biosafety Committee (IBC) of the hospital before the laboratory official operation. The measures involved in specimen transportation are as follows:

- I. Each sample should be individually packaged in a transparent plastic bag [6].
- II. All specimens should be transported through the specimen transport box (UN2814, Figure 2).
- III. The outer layer of the transfer box shall be packed with disposable medical waste bags with at least 2 layers, and each layer shall be thoroughly disinfected with appropriate disinfectants such as 70% ethanol.
- IV. Check the number of samples by using electronic lists of Laboratory Information System (LIS).
- V. After the experiment, the number of specimens should be checked by two persons to ensure that all specimens are properly disposed of and do not leak out of the laboratory. All specimens and taxidermy related articles, such as sharps containers, personal protective equipment (PPE), and packing bags, should be autoclaved.
- VI. Distributing food to the NAT laboratory to reduce the range of activities for laboratory staff.
- VII. Before leaving the hospital, the NAT laboratory staff shall go to a designated bathroom to take shower and change clothes.
- VIII. Rotation for recuperation should be executed monthly.
- IX. Laboratory technicians should have regular physical examination.

## DISCUSSION

As one of hospital laboratories, the number of laboratory doctors may not increase at any time. The first challenging is how to increase the laboratory testing capacity. According to our experience, the manual method of nucleic acid extraction does a maximum of 48 samples every 4 hours. However, with the use of an automated nucleic acid extraction system, the speed of the experiment will be determined according to the speed of the instrument. The system we used (Tianlong Nucleic Acid Extractor Libexm, Xi'an Tianlong Science and Technology Co., Ltd, Xi'an, Shanxi, PRC) in Stage I can process 32 samples per batch. With the nucleic acid extraction system, we can test 128 samples every 4 hours. Nevertheless, this is still far below the speed of the extraction-free method we used in the Stage II. However, the laboratory, especially for small laboratories like us, cannot blindly increase the laboratory testing capacity. This should be adjusted according to the number of laboratory doctors and their physical acceptability. It is a physical challenge for laboratory doctors to wear full PPE, such as breathing difficulties caused by double masks, the restlessness of fogged eye protection, and the headache of working in a negative pressure

environment for a long time. Therefore, even when our sample size was the largest, the duration of each experiment would not exceed 5 hours.

One thing that needs special attention, the negative pressure in the laboratory should be adjusted timely when we use the BSC type B2. If the negative pressure system in the laboratory cannot be adaptive adjusted, BSC type B2 will further reduce the negative pressure in the laboratory. This poses a safety hazard for laboratory doctors.

As of June 7, the total number of specimens tested in the NAT laboratory was 27,778. There were 5 positive specimens among them. As an important link in the prevention and treatment of COVID-19, it is indispensable for the NAT laboratory to operate safely and orderly.

## CONCLUSION

Our experience can be summarized into the following three aspects: i. Reasonable personnel arrangement, ii. Preventing the contamination of specimens, and iii. Maintaining the health of laboratory doctors.

### Declaration of Interest:

We declare no conflicts of interest.

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