


SHORT COMMUNICATION

SARS-CoV-2 can be detected in urine, blood, anal swabs, and oropharyngeal swabs specimens

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Funding information

National Natural Science Foundation of China, Grant/Award Numbers: 81570539, 81873572; Guangdong Province Science and Technology Project, Grant/Award Number: 2020B111105001

Abstract

Purpose: The purpose of this study was to detect severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) ribonucleic acid (RNA) in urine and blood specimens, and anal and oropharyngeal swabs from patients with confirmed SARS-CoV-2 infection, and correlated positive results with clinical findings.

Methods: Patients with confirmed SARS-CoV-2 infections were included in this study. Patients' demographic and clinical data were recorded. Quantitative real-time polymerase chain reaction was used to detect SARS-CoV-2 RNA in urine and blood specimens, and anal and oropharyngeal swabs. The study is registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (No. NCT04279782, 19 February, 2020).

Results: SARS-CoV-2 RNA was present in all four specimen types, though not all specimen types were positive simultaneously. The presence of viral RNA was not necessarily predictive of clinical symptoms, for example, the presence of viral RNA in the urine did not necessarily predict urinary tract symptoms.

Conclusions: SARS-CoV-2 can infect multiple systems, including the urinary tract. Testing different specimen types may be useful for monitoring disease changes and progression, and for establishing a prognosis.

KEYWORDS

prognosis, real-time polymerase chain reaction, SARS-CoV-2, specimens, urine

1 | INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which was first identified in Wuhan, China, has spread in almost every country in the world. On 30 January, 2020, World Health Organization (WHO) declared SARS-CoV-2 infection as a global health emergency. There have been 2 074 529 confirmed cases of COVID-19 around the world, including 139 378 (6.72%) deaths, reported to WHO on 17 April, 2020.¹

SARS-CoV-2 is similar to severe acute respiratory syndrome coronavirus (SARS-CoV), which spread globally from November 2002

to July 2003,² and Middle East respiratory syndrome coronavirus, which was first reported in Saudi Arabia in 2012.³ A prospective study enrolled 41 patients with laboratory-confirmed SARS-CoV-2 infection. All respiratory specimens from them were positive for SARS-CoV-2, but blood specimens from only six of them were positive.⁴ In the first case in the United States, the nasopharyngeal swab, oropharyngeal swab, serum, urine, and stool specimens were examined for SARS-CoV-2. The nasopharyngeal swab, oropharyngeal swab, and stool specimens were positive.⁵ Despite a vast amount of ongoing research, the mechanism of SARS-CoV-2 infection and the propensity for organ invasion is not known. The relations between

clinical manifestations, organ system involvement, and the presence of viral ribonucleic acid (RNA) in specimens such as blood and urine are not known. Understanding these relations may help to improve the early diagnosis rate and reduce the spread of the disease.

Thus, the purpose of this study was to determine the presence of SARS-CoV-2 RNA in the urine, blood, anal swab, and oropharyngeal swab specimens of patients with confirmed SARS-CoV-2 infections, and examine the relations of positive results with clinical manifestations.

2 | MATERIALS AND METHODS

2.1 | Patients

Patients with suspected SARS-CoV-2 infections who were admitted to the isolation unit of the Third Affiliated Hospital of Sun Yat-sen University were potentially eligible for inclusion in the study. After admission, oropharyngeal swabs were obtained and sent to the local Center for Disease Control and Prevention (CDC) for detection of SARS-CoV-2 RNA. A positive result was considered laboratory confirmation of SARS-CoV-2 infection, and patients with a laboratory-confirmed diagnosis of SARS-CoV-2 infection were included in the study.⁶ The study was approved by the Institutional Review Board of the Third Affiliated Hospital of Sun Yat-sen University, and all patients provided voluntarily, signed written informed consent for participation in the study. The study is registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (No. NCT04279782, 19 February, 2020).

2.2 | SARS-CoV-2 RNA detection

Patient urine, blood, anal swabs, and pharyngeal swab specimens were obtained and stored between 2 and 8°C until detection of SARS-CoV-2 RNA. Briefly, SARS-CoV-2 RNA was isolated from a 600 µL sample using a Nucleic Acid Extraction and Purification Kit (SUPI-1017; Supbio, Guangzhou, China), according to the manufacturer's protocol. The levels of SARS-CoV-2 RNA were detected by quantitative real-time polymerase chain reaction (qRT-PCR) using a SLAN-96P Real-time PCR Detection System (Hongshi, Shanghai, China). The TaqMan probe method was used with a SARS-CoV-2 RNA Detection Kit (SUPI-0509; Supbio). The primers and probe were designed to detect the N gene.

2.3 | Data collection

Patients' demographic and clinical data were recorded. Clinical data and information obtained included epidemiological history, underlying diseases, signs and symptoms, blood cell counts and biochemical test results, chest computed tomography (CT) results, and the levels of SARS-CoV-2 RNA of the four specimens.

3 | RESULTS

3.1 | Baseline characteristics

Of 74 patients admitted to the isolation unit with suspected SARS-CoV-2 infections from 22 January, 2020 to 29 February, 2020, 13 were confirmed diagnosed with SARS-CoV-2 infections by the CDC using qualitative nucleic acid detection, and nine patients were enrolled in this study (rest four patients were transferred to another hospital without collecting their specimens). The average age of the nine patients was 38.9 ± 11.8 years, and there were five females and four males. Eight of the patients had a clear epidemiological history, including contact with a patient with a documented infection within the past 14 days, or living in a region with a high infection rate. The other patient did not have a clear epidemiological history. Only one patient had comorbidities of hypertension and hyperthyroidism. The most common symptoms were fever (100% of patients) and cough (67% of patients). Other symptoms included sore throat (33%), fatigue (22%), and diarrhea (11%). No patients complained of dyspnea or urinary tract symptoms. Baseline characteristics of the nine patients infected with SARS-CoV-2 are shown in Table 1.

3.2 | Standard laboratory test

Standard laboratory test results are shown in Table 1. The results showed that the white blood cell counts were normal in all nine patients, but the lymphocytes decreased in four patients. All patients had a partial arterial oxygen pressure of more than 80 mm Hg, and no patients had any indications of hypoxia. Aspartate aminotransferase and creatine kinase levels slightly increased in one patient (Patient 9) (37 U/L and 186 U/L, respectively). Tests of liver and renal function, myocardial enzymes, and prothrombin time of the other eight patients were normal. C-reactive protein increased in six patients, and erythrocyte sedimentation rate increased in five patients. Procalcitonin level was normal in all patients. Influenza A and B antigen, mycoplasma antigen, and respiratory syncytial virus antigen were negative in all patients. In all patients, chest CT showed ground-glass changes but no evidence of lesion consolidation.

3.3 | Quantitative real-time polymerase chain reaction analysis

The results of qRT-PCR analysis for the detection of the SARS-CoV-2 N gene in urine, blood, anal swabs, and oropharyngeal swabs specimens are shown in Table 2, which indicated that viral RNA was detectable in all four specimen types. Of the nine patients, seven were positive for oropharyngeal swab specimens, two were positive for anal swabs specimens, two were positive for blood specimens, and one was positive for urine specimens. All the four specimens were negative in Patient 1 on day 15 after symptom onset. Oropharyngeal swab specimen was positive and the rest three specimens were negative in Patient 2 on day 17 after

TABLE 1 Baseline characteristics of patients infected with SARS-CoV-2

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Total number (%)
Age, y	37	46	27	27	62	30	31	49	41	
Sex	Male	Female	Female	Female	Female	Male	Female	Male	Male	
Epidemiological history	Yes ^a	Yes ^a	Yes ^a	Yes ^a	Yes ^b	Yes ^a	Yes ^a	Yes ^a	Uncertain	
Underlying disease	-	-	-	-	-	-	-	+ ^c	-	1 (11%)
Symptoms										
Fever	+	+	+	+	+	+	+	+	+	9 (100%)
Cough	+	+	-	-	+	+	-	+	+	6 (67%)
Sputum, productive	-	+	-	-	-	+	-	+	-	3 (33%)
Dyspnea	-	-	-	-	-	-	-	-	-	0
Sneezing	-	-	-	-	-	-	-	-	-	0
Sore throat	-	+	-	+	+	-	-	-	-	3 (33%)
Fatigue	+	-	+	-	-	-	-	-	-	2 (22%)
Diarrhea	-	-	-	-	-	-	-	+	-	1 (11%)
Urinary tract irritation	-	-	-	-	-	-	-	-	-	0
White blood cell count, $\times 10^9/L$	4.59	4.21	4.94	5.03	7.3	5.37	3.8	4.5	4	
Lymphocyte count, $\times 10^9/L$	1.0	1.19	1.28	0.72	2.98	1.5	1.28	0.69	0.88	
Lymphopenia ($<1.1 \times 10^9/L$)	+	-	-	+	-	-	-	+	+	4 (44%)
PaO ₂ , mm Hg	94.1	105	102	102	83.1	187	128	83.6	98.6	
Aspartate aminotransferase, U/L (normal range 3-35)	16	19	17	21	24	17	22	16	19	
Alanine aminotransferase, U/L (normal range 14-40)	15	22	7	12	13	13	13	11	37	
Creatinine, $\mu\text{mol/L}$ (normal range 31.8-116)	93	82	58	58	56	72	56	66	66	
Lactate dehydrogenase, U/L (normal range 71-231)	191	194	152	180	152	189	167	187	198	
Creatine kinase, U/L (normal range 24-184)	103	45	55	94	75	73	60	44	186	
C-reactive protein, mg/L (normal range 0-6.0)	9.1	7.46	10.4	6.7	7.9	6.7	0.6	1.8	<0.05	
Erythrocyte sedimentation rate, mm/H (normal range 0-15)	7	37	21	7	31	10	12	18	18	
Chest CT findings										
Ground-glass opacities	+	+	+	+	+	+	+	+	+	
Consolidation	-	-	-	-	-	-	-	-	-	

Abbreviations: CT, computed tomography; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

^aContact with infected patient.

^bExposure to epidemic area.

^cPatient 8 had underlying hypertension and hyperthyroidism.

symptom onset. Oropharyngeal swab specimen was positive and the rest three specimens were negative in Patient 3 on day 8 after symptom onset. Blood and oropharyngeal swab specimens were positive and the rest two specimens were negative in Patient 4 on day 3 after symptom onset. All four specimens were negative in Patient 5 on day 10 after symptom onset. Oropharyngeal swab specimen was positive and the rest three specimens were negative in Patient 6 on day 8 after symptom

onset. Urine and oropharyngeal swab specimens were positive and the rest two specimens were negative in Patient 7 on day 7 after symptom onset. Blood, oropharyngeal swab, and anal swab specimens were positive and urine specimen was negative in Patient 8 on day 3 after symptom onset. Oropharyngeal swab and anal swab specimens were positive and the rest two specimens were negative in Patient 9 on day 3 after symptom onset.

TABLE 2 Results of qRT-PCR specimen testing and clinical outcomes of patients infected with SARS-CoV-2

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Total number (%)
Days from symptom onset to sample collection	15	17	8	3	10	8	7	3	3	
qRT-PCR, copies/mL										
Oropharyngeal swab	ND	4.56E+02	2.41E+04	1.14E+04	ND	6.11E+03	6.77E+04	9.83E+03	2.29E+04	7 (78%)
Blood	ND	ND	ND	8.04E+00	ND	ND	ND	9.11E+01	ND	2 (22%)
Urine	ND	ND	ND	ND	ND	ND	3.22E+02	ND	ND	1 (11%)
Anal swab	ND	ND	ND	ND	ND	ND	ND	4.47E+02	5.42E+04	2 (22%)
Treatment										
Antiviral therapy										
Arbidol	+	+	+	+	+	+	+	-	-	7 (78%)
Lopinavir and ritonavir	+	+	+	+	+	+	+	+	+	9 (100%)
Interferon alfa-2b inhalation	+	-	-	-	-	-	-	-	-	1 (11%)
Oxygen support	+	-	-	-	-	+	+	+	-	4 (44%)
Outcome	Recovery	Recovery	Improving	Recovery	Recovery	Improving	Recovery	Improving	Improving	
Days from admission to discharge	16	16	NA	22	31	NA	18	NA	NA	

Abbreviations: NA, not available (patients have not been discharged from hospital); ND, not detected; qRT-PCR, quantitative real-time polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

3.4 | Treatment and clinical outcome

All patients received antiviral treatment with lopinavir/ritonavir. Seven patients were also treated with arbidol, and one patient was administered interferon alfa inhalation. Four patients required supplemental oxygen support. At the time this report was prepared, five patients had recovered and were discharged, and four patients were still hospitalized with improvements in their conditions.

4 | DISCUSSION

The pathogenic mechanism of SARS-CoV-2 infection is still unclear. Current evidence indicates that it can invade multiple organ systems, including the respiratory system, digestive system, and hematological system.^{4,5,7} Whether it can invade the urinary system has not been determined. A study reported the presence of SARS-CoV-2 in 1070 specimens of bronchoalveolar lavage fluid, sputum, nasal and pharyngeal swabs, fibrobronchoscope brush biopsy, feces, and blood from 205 patients. However, none of the 72 urine specimens tested positive.⁸ The current study is the first in which SARS-CoV-2 RNA was identified in the urine of an infected patient, though the patient did not have any urinary tract symptoms.

Interestingly, not all patients with positive anal swab specimens had diarrhea, and not all patients with positive urine specimens had urinary tract symptoms. Thus, it appears that SARS-CoV-2 can invade the urinary system, hematological system, and digestive system; however, symptoms related to infection of these body systems may not be present. In patients with mild infections, the disease may be self-limiting.

The study has some limitations. First, only nine patients were enrolled in the study. Second, four types of specimens were detected for SARS-CoV-2 RNA once in the course without dynamic examinations.

SARS-CoV-2 can infect multiple systems, including the urinary tract. Testing different specimen types may be useful for monitoring disease changes and progression, and for establishing a prognosis. Testing different types of specimens may be useful even without corresponding clinical symptoms.

ACKNOWLEDGMENTS

The authors thank all the medical staff of the isolation unit of Third Affiliated Hospital of Sun Yat-sen University. This study was supported

by grants from the Natural Science Foundation of China (No. 81570539 and 81873572), Tackling of the Key Scientific and Emergency Special Program of Sun Yat-sen University and the Emergency Special Program for 2019-nCoV of Guangdong Province Science and Technology Project (No. 2020B111105001).

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REFERENCES

1. World Health Organization. Coronavirus disease (COVID-19) Situation dashboard. World Health Organization website. <https://who.sprinklr.com/>. Accessed April 17, 2020.
2. World Health Organization. Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003. World Health Organization website. https://www.who.int/csr/sars/country/table2004_04_21/en. Accessed February 13, 2020.
3. World Health Organization. Middle East respiratory syndrome coronavirus (MERS-CoV). World Health Organization website. <http://www.who.int/emergencies/mers-cov/en>. Accessed February 13, 2020.
4. Huang CL, Wang YM, Li XW, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet*. 2020;395:497-506. [https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5)
5. Holshue ML, DeBolt C, Lindquist S, et al. First case of 2019 novel coronavirus in the United States. *N Engl J Med*. 2020;382:929-936. <https://doi.org/10.1056/NEJMoa2001191>
6. National Health Commission of the People's Republic of China. Diagnosis and treatment program for 2019 Novel Coronavirus pneumonia. National Health Commission of the People's Republic of China website. <http://www.nhc.gov.cn/xcs/zhengcwj/202001/f492c9153ea9437bb587ce2ffcbee1fa/files/39e7578d85964dbe81117736dd789d8f.pdf>. Accessed February 13, 2020.
7. Chan JFW, Yuan SF, Kok KH, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *The Lancet*. 2020;395:514-523. [https://doi.org/10.1016/s0140-6736\(20\)30154-9](https://doi.org/10.1016/s0140-6736(20)30154-9)
8. Wang WL, Xu YL, Gao RQ, et al. Detection of SARS-CoV-2 in different types of clinical specimens. *JAMA*. 2020. <https://doi.org/10.1001/jama.2020.3786>

How to cite this article: Peng L, Liu J, Xu W, et al. SARS-CoV-2 can be detected in urine, blood, anal swabs, and oropharyngeal swab specimens. *J Med Virol*. 2020;92:1676-1680. <https://doi.org/10.1002/jmv.25936>