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Infections

Risk Assessment and Prevention of Severe Acute Respiratory Syndrome Coronavirus 2 Transmission for Hospitalized Urological Patients After the COVID-19 Pandemic in Wuhan, China

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Article info

Abstract

Background: Emerging asymptomatic severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections were detected and multiple cases were found to be SARS-CoV-2 positive again, which raised an alarm for the patients hospitalized after the coronavirus disease 2019 (COVID-19) pandemic.

Objective: We investigated the risk and prevention of hospital transmission of SARS-CoV-2 to hospitalized urological patients.

Design, setting, and participants: This is a retrospective study of 319 hospitalized urological patients enrolled between April 20, 2020 and May 11, 2020 from two tertiary hospitals in Wuhan, China.

Intervention: Chest computed tomography (CT) images, nucleic acid tests (NATs), and serum antibody were examined at the outpatient department and 1 wk after admission for all patients.

Outcome measurements and statistical analysis: The chest CT images, NATs, serum antibody results, and clinical data were collected and analyzed.

Results and limitations: None of the 319 patients was found to be SARS-CoV-2 NAT positive. Ten and four patients were detected to be immunoglobulin (Ig)G and IgM positive, respectively. The chest CT features of 116 patients showed abnormal lung findings. During the 1-wk isolation, one patient initially being IgG positive only was found to be IgM positive, and another initially IgM-positive patient had a rising IgG level. Through risk assessment, we identified seven patients with very high and high risk for hospital transmission, and delayed the surgery while maintaining close follow-up. Five intermediate-risk patients were operated on successfully under paravertebral block or epidural anesthesia to avoid opening the airway with endotracheal intubation. The remaining 104 low-risk and 203 normal patients underwent normal surgery.

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Conclusions: Of the 319 patients, seven were identified as very high and high risk, which reinforced the importance of epidemic surveillance of discharged COVID-19 patients and asymptomatic infections. Five intermediate-risk patients were operated on successfully under regional anesthesia.

Patient summary: Our experience of risk assessment and management practice may provide a strategy to prevent severe acute respiratory syndrome coronavirus 2 transmission to hospitalized urological patients after the coronavirus disease 2019 (COVID-19) pandemic.

1. Introduction

With its rapid spread, coronavirus disease 2019 (COVID-19) has caused widespread concern all over the world and was declared a pandemic on March 11, 2020 by the World Health Organization (WHO) [1]. The Chinese city of Wuhan, the epicenter of the COVID-19 early outbreak, has been reversed successfully by social distancing and lockdown for 76 d. Now life is returning to normal and standard health care services are resuming slowly.

The positive result of nucleic acid tests (NATs) is the current gold standard to confirm severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, but the diagnostic accuracy is reported to range from 30% to 50%, which remains controversial [2,3]. For the current COVID-19 pandemic, there have been several reports of false negative results for people who are actually infected with SARS-CoV-2. Many suspected patients exhibited typical clinical symptoms or imaging features consistent with pneumonia, but were not found to be positive by NATs [4]. False negative NAT results of these patients raised a concern.

Asymptomatic people are defined as those who carry the active SARS-CoV-2 virus in their body but show no related symptoms. Chinese researchers suggested that up to 25% of those who become infected with the novel coronavirus may not show symptoms [5]. Mizumoto et al [6] estimated that the asymptomatic proportion of infections was 17.9% in Yokohama, Japan. The high percentage of SARS-CoV-2–infected yet asymptomatic people could contribute to the spread of the coronavirus across the world, if they are not detected.

SARS-CoV-2 RNA from respiratory tract specimens may be sustained and become positive again during the course of COVID-19. Emerging evidence has found the recurrence of positive SARS-CoV-2 RNA in discharged patients [7]. Yao et al [8] performed a postmortem pathological study in a 78-yr-old ready-for-discharge COVID-19 patient who unfortunately died from sudden cardiac arrest and revealed that SARS-CoV-2 viruses remained in pneumocytes.

The false negative results of NATs, existence of asymptomatic transmission, and multiple cases being positive again among discharged or ready-for-discharge COVID-19 patients raised concerns for the hospitalized patients who were scheduled for urological surgery after the COVID-19 pandemic in Wuhan. Here, we investigated the risk and prevention of hospital transmission of SARS-CoV-2 to urological patients, while preparing for a second wave of COVID-19.

2. Patients and methods

2.1. Study design and participants

We conducted a retrospective review of hospitalized urological patients from two tertiary hospitals in Wuhan: Tongji Hospital (Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology) and TCM Hospital (Hubei Provincial Hospital of Traditional Chinese Medicine). For all enrolled patients, demographic information, history of COVID-19, epidemiology, clinical data, chest computed tomography (CT) scan findings, NAT results, and immunoglobulin (Ig)M and IgG antibodies from the outpatient setting to hospital admission were obtained from the clinical records. All patients with suspected or confirmed COVID-19 were diagnosed based on the Diagnosis and treatment protocol for novel coronavirus pneumonia (seventh edition), published by the National Health Commission and State Administration of Traditional Chinese Medicine.

2.2. Chest CT examination and CT review

A total of 319 urological patients were enrolled from April 20, 2020 to May 11, 2020. CT (CT HD750 Discovery; GE) examination follows the common chest CT scan protocol. Two certificated chest CT radiologists with 5–10 yr of experience independently reviewed the CT images while they were blinded to the clinical information of the patients.

2.3. Nucleic acid tests

Upper respiratory tract samples, including nasopharyngeal and oropharyngeal swab, were collected from all the patients. SARS-CoV-2 open reading frame 1ab(ORF1ab)/nucleocapsid protein (N) gene was detected by quantitative reverse transcription polymerase chain reaction (qRT-PCR) using the double nucleic acid detection kit (BioGerm, Shanghai, China), following WHO guidelines [9,10].

2.4. Antibody measurement

The IgG and IgM antibodies against SARS-CoV-2 in serum samples were detected using a sandwich enzyme-linked immunosorbent assay (ELISA) kit following the manufacturer's instructions. The levels of IgG and IgM antibodies were positively correlated with the relative luminescence

unit and were expressed in arbitrary units per milliliter (AU/mL). Any test showing an IgG/IgM result of >10 AU/mL was considered positive.

2.5. Statistical analysis

Continue variables were described as mean ± standard deviation for normal distribution data or as median with interquartile range for non-normal distribution data. Categorical variables were expressed as numbers (%). Paired Student t tests were used to analyze group differences. Two-sided p values of <0.05 were considered statistically significant. SPSS version 21.0 (SPSS Inc., Chicago, IL, USA) and Prism 7 (GraphPad, La Jolla, CA, USA) were used to analyze the data.

2.6. Ethical approval

Ethical approval was exempted by the hospital institutional review board, since we collected and analyzed all the data from patients according to the policy for public health outbreak investigation of emerging infectious diseases issued by the National Health Commission of China.

3. Results

3.1. Demographics and clinical characteristics

A total of 319 hospitalized urological patients were included in this study: 172 (53.9%) from Tongji Hospital and 147 (46.1%) from TCM Hospital. The mean age of the study participants was 52.24 ± 15.09 yr; there were 233 (73.0%) males and 86 (27.0%) females. All the patients had an epidemiological history exposure to COVID-19. Most of the patients in this study were people without a previous history of COVID-19; only one patient with mild COVID-19 was treated and discharged in the makeshift hospital after two NATs were negative. Eleven (3.45%) patients had fever or respiratory symptoms. In all, 187 (58.6%) patients are Wuhan citizens, 121 (37.9%) are from other cities in Hubei province, and 11 (3.45%) are from outside of Hubei. Of the 319 patients, 116 (36.4%) were reported to have abnormal findings in the lung CT scan. Of the patients, 3.13% (10/319) were positive with IgG and 1.25% (four/319) were positive with IgM. The baseline demographic information and clinical characteristics are shown in Table 1.

3.2. Changes in the spectrum of urological disorders

Compared with the same period in the previous year, there was a 44.4% reduction in the total number of hospitalized urological patients. For the changes in the spectrum of urological disorders, a significant increase was shown in urogenital cancer patients ($p = 0.03$) and those with nonfunctional kidneys with hydronephrosis ($p = 0.02$). While there was a significant decrease in endoscopic interventions for stone disease ($p = 0.03$) and endoscopic surgery in transurethral resection of the prostate (TURP; $p = 0.04$), there was no change in the proportion of other urological diseases over the study period (Table 2).

Table 1 – Baseline characteristics of 319 hospitalized urological patients after the COVID-19 pandemic in Wuhan.

Variables	Total	Tongji Hospital	TCM Hospital
Age	52.24 ± 15.09	51.84 ± 13.37	52.64 ± 16.59
Gender			
Male	233/319 (73.0)	121/172 (70.3)	112/147 (76.2)
Female	86/319 (27.0)	51/172 (29.7)	35/147 (23.8)
Address			
Wuhan city	187/319 (59.6)	48/172 (27.9)	139/147 (94.5)
Hubei province except Wuhan	121/319 (37.9)	115/172 (66.9)	6/147 (4.08)
Outside of Hubei	11/319 (3.45)	9/172 (5.23)	2/147 (1.36)
Epidemiological history[a]			
1	311/319 (97.5)	168/172 (97.7)	143/147 (97.3)
2	1/319 (0.31)	0	1/147 (0.68)
3	7/319 (2.19)	4/172 (1.25)	3/147 (2.04)
4	0	0	0
Fever or respiratory symptoms	11/319 (34.5)	6/172 (2.32)	5/147 (3.40)
Routine blood			
Decreased WBC counts	5/319 (1.57)	3/172 (1.74)	2/147 (1.36)
Reduced lymphocyte counts	20/319 (6.27)	12/172 (6.98)	8/147 (5.44)
Abnormal lung CT	116/319 (36.4)	66/172 (38.4)	50/147 (34.0)
Nucleic acid test (+)	0	0	0
IgG (+)	10/319 (3.13)	6/172 (3.49)	4/147 (2.72)
IgM (+)	4/319 (1.25)	2/172 (1.16)	2/147 (1.36)

Data are presented as mean ± standard deviation or n/N (%).
COVID-19 = coronavirus disease 2019; CT = computed tomography; IgG = immunoglobulin G; IgM = immunoglobulin M; WBC = white blood cell.
[a] Epidemiological history: (1) travel or residence history in Wuhan and surrounding areas, or other communities with reported cases, within 14 d before the onset of illness; (2) history of exposure to COVID-19 patients within 14 d prior to the onset of illness; (3) contact with patients with fever or respiratory symptoms within 14 d before onset; and (4) cluster (more than two cases with fever and/or respiratory symptoms within 2 wk).

3.3. Chest CT, NATs, and IgM and IgG antibody detection

All patients had a negative result in the NATs; 116 patients showed abnormal findings in the lung CT scan, including 55 patients with the appearance of ground-glass opacities or patch features, defined as chest CT (++), and 61 patients with lung fibrotic streak changes, defined as chest CT (+). Among the 55 chest CT (++) patients who were tested for serological antibodies, three were positive for both antibodies, one was positive for IgM only, three were positive for IgG only, and 48 were negative for both antibodies. Among the 61 chest CT (+) patients, none was positive for both antibodies or for IgM only, five were positive for IgG only, and 56 were negative for both antibodies. All the 203 chest CT (−) patients were negative for both antibodies. A further subgroup analysis was performed based on the chest CT findings, NATs, and IgM and IgG antibody detection (Table 3).

3.4. Risk assessment and surgery management

To predict who is at a high risk of hospital transmission during the urological surgery, we propose a risk classification system that evaluates the risk of SARS-CoV-2 transmission for hospitalized patients (Table 4). According to the risk definitions, the patients were classified into five groups: very-high-,

Table 2 – Changes in the types of urological diseases compared with the same period of the previous year.

Disease	April 20, 2020–May 11, 2020	April 20, 2019–May 11, 2019	p value
Cancer	113/319 (35.4)	164/574 (28.6)	**0.03**
Renal cancer	29/319 (9.1)	42/574 (7.3)	
Ureteral cancer	8/319 (2.5)	12/574 (2.1)	
Bladder cancer	42/319 (13.2)	63/574 (11.0)	
Prostate cancer	32/319 (10.0)	46/574 (8.0)	
Penile cancer	2/319 (0.6)	1/574 (0.2)	
Adrenal tumor	31/319 (9.7)	47/574 (8.2)	0.44
Renal cyst	4/319 (1.25)	11/574 (1.9)	0.46
Hydronephrosis with ureteral stricture	39/319 (12.2)	44/574 (7.7)	**0.02**
Stone	103/319 (32.3)	227/574 (39.5)	**0.03**
Kidney stone	40/319 (12.5)	89/574 (15.5)	
Kidney-ureteral stone	38/319 (11.9)	72/574 (12.5)	
Ureteral stone	20/319 (6.3)	55/574 (9.6)	
Bladder stone	5/319 (1.6)	11/579 (1.9)	
BPH	17/319 (5.3)	53/574 (9.2)	**0.04**
Others	12/319 (3.8)	29/574 (5.1)	0.38
Renal tuberculosis	2/319 (0.6)	4/574 (0.7)	
Urethral stricture	2/319 (0.6)	5/574 (0.9)	
Stress incontinence	2/319 (0.6)	8/574 (1.4)	
Varicocele	2/319 (0.6)	5/574 (0.9)	
Hydrocele	1/319 (0.3)	4/574 (0.7)	
Azoospermia	1/319 (0.3)	2/574 (0.3)	
Testicular torsion	1/319 (0.3)	1/574 (0.2)	

Data are presented as n/N (%).
BPH = benign prostate hyperplasia.

high-, intermediate-, low-, and normal-risk groups. Very-high-risk individuals are defined as those with NAT (+) or IgM (+). High-risk individuals are defined as those with NATs (−), IgG (+), IgM (−), and chest CT showing abnormal lung findings consistent with the radiographic features of COVID-19 infection stage, or those with a history of SARS-CoV-2 infection, NATs (−), IgG (−), IgM (−), and chest CT showing abnormal lung findings consistent with the radiographic features of COVID-19 infection stage. Intermediate-risk individuals are defined as those with NATs (−), IgG (+), IgM (−), and chest CT showing abnormal lung findings consistent with the radiographic features of COVID-19 convalescence stage, or those with a history of SARS-CoV-2 infection, NATs (−), IgG (−), IgM (−), and chest CT showing abnormal lung findings consistent with the radiographic features of COVID-19 convalescence stage. Low-risk individuals are defined as those with NATs (−), IgG (+), IgM (−), and chest CT showing normal lung findings; those with a history of SARS-CoV-2 infection, NATs (−), IgG (−), IgM (−), and chest CT showing normal lung findings; or those without a history of SARS-CoV-2 infection, NATs (−), IgG (−), IgM (−), and chest CT showing abnormal lung findings. The normal individuals are defined as patients without a history of SARS-CoV-2 infection, NATs (−), IgG (−), IgM (−), and chest CT showing normal lung findings. For the very high- and high risk patients, we recommended delaying the surgery and closely following the NATs, IgG, IgM, and chest CT changes. For emergency surgery, dedicated COVID-19 OR/ward facilities should be provided. For the intermediate-risk patients, we recommended regional block anesthesia to avoid general anesthesia with endotracheal intubation (Fig. 1).

In total, three (0.94%), four (1.25%), five (1.57%), and 104 (32.6%) of the 319 patients scheduled for the urological surgery were at a very high, high, intermediate, and low risk of hospital transmission according to our categorization (Table 5). During the 1-wk isolation in the observation ward, one patient who was initially IgG positive only became IgM positive also, escalating to very high risk from high risk, while another initially IgM-positive patient had a rising IgG level (Table 5). By risk assessment, we identified seven patients with very high and high risk for hospital transmission, and delayed the surgery while maintaining close follow-up (Table 6). Five intermediate-risk patients were operated successfully under regional block anesthesia, including paravertebral block or epidural anesthesia, to avoid opening the airway with endotracheal intubation (Table 7). The remaining 104 low-risk and 203 normal patients underwent normal surgery (Table 5).

4. Discussion

Wuhan was the epicenter of the COVID-19 outbreak, and now life is gradually returning to normal after lockdown for 76 d [11]. In a recent study, Luciani et al [12] described the risk of COVID-19 in a COVID-free urology unit. In the present study, we comprehensively investigated the risk assessment and management practice to provide strategies to prevent SARS-CoV-2 transmission for hospitalized urological patients after the COVID-19 pandemic in Wuhan.

Owing to the lockdown, accumulating urogenital cancer patients are in urgent need of treatment because the disease is life threatening. Chronic hydronephrosis if not treated may finally lead to nonfunctional kidneys, requiring surgical intervention. However, there was a significant decrease in endoscopic interventions for stone disease and endoscopic surgery in TURP [13]. Many of these diseases are chronic in nature and affect individuals not only by shortening their survival, but also by impairing their quality of life [14]. Some of these patients preferred conservative treatment during the COVID-19 pandemic.

Currently, RT-PCR–based SARS-CoV-2 viral RNA detection is the standard to diagnose COVID-19 in clinical practice. However, the reported positive rate varied from 30% to 50% for different swab specimens in COVID-19 patients. Many cases that were strongly epidemiologically linked to SARS-CoV-2 exposure and with typical lung CT findings still remained NAT negative in their upper respiratory tract samples [15,16]. Emerging evidence has found more and more cases of asymptomatic SARS-CoV-2 infections being detected and discharged COVID-19 patients turning positive again [5,7].

The serological antibodies against SARS-CoV-2 could be detected in the middle and later stage of the disease course. IgM and IgG antibody tests have shown great specificity for the diagnosis of COVID-19 [17]. Compared with RT-PCR, serological detection has advantages with faster turnaround time, high throughput, and less workload to function as a crucial complement approach for NATs [17,18]. Evidence demonstrated that the median time of seroconversion was 11 d for IgG and 14 d for IgM after disease onset [19]. IgM antibody appeared within 7 d after SARS-CoV-2 infection, and

Table 3 – Chest CT, SARS-CoV-2 nucleic acid test, and IgM and IgG antibody detection of 319 hospitalized urological patients after the COVID-19 pandemic in Wuhan.

Nucleic acid	Chest CT scan[a]	IgG	IgM	Total	Tongji Hospital	TCM Hospital
Nucleic acid test (−)	Chest CT (++)	IgG (+)	IgM (+)	3/319 (0.94)	2/172 (1.16)	1/147 (0.68)
		IgG (−)	IgM (+)	1/319 (0.31)	0	1/147 (0.68)
		IgG (+)	IgM (−)	3/319 (0.94)	3/172 (1.74)	0
		IgG (−)	IgM (−)	48/319 (15.0)	22/172 (12.8)	26/147 (17.7)
	Chest CT (+)	IgG (+)	IgM (+)	0	0	0
		IgG (−)	IgM (+)	0	0	0
		IgG (+)	IgM (−)	5/319 (1.57)	3/172 (1.74)	2/147 (1.36)
		IgG (−)	IgM (−)	56/319 (17.56)	36/172 (20.9)	20/147 (13.6)
	Chest CT (−)	IgG (+)	IgM (+)	0	0	0
		IgG (−)	IgM (+)	0	0	0
		IgG (+)	IgM (−)	0	0	0
		IgG (−)	IgM (−)	203/319 (63.6)	106/172 (61.6)	97/147 (66.0)

Data are presented as n/N (%).
COVID-19 = coronavirus disease 2019; CT = computed tomography; IgG = immunoglobulin G; IgM = immunoglobulin M; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
[a] Chest CT (++) was defined as the appearance of ground-glass opacities or patch features; chest CT (+) was defined as finding of lung fibrotic streak changes; and chest CT (−) was defined as normal findings in the lung CT scan.

Table 4 – Risk definition, assessment, and prevention of SARS-CoV-2 transmission for hospitalized urological patients after the COVID-19 pandemic in Wuhan.

Risk grade	Risk definitions	Surgical management
Very high risk	Satisfy either of the following two: 1. Nucleic acid test (+) 2. IgM (+)	For emergency surgery, dedicated COVID-19 OR/ward facilities; for elective surgery, delaying the surgery and close follow-up depending on the nucleic acid test, IgG, IgM, and chest CT changes
High risk	Satisfy either of the following two: 1. Nucleic acid test (−), IgG (+), IgM (−), and chest CT showed abnormal lung findings consistent with the radiographic features of COVID-19 infection stage[a] 2. History of SARS-CoV-2 infection, nucleic acid test (−), IgG (−), IgM (−), and chest CT showed abnormal lung findings consistent with the radiographic features of COVID-19 infection stage	
Intermediate risk	Satisfy either of the following two: 1. Nucleic acid test (−), IgG (+), IgM (−), and chest CT showed abnormal lung findings consistent with the radiographic features of COVID-19 convalescence stage[b] 2. History of SARS-CoV-2 infection, nucleic acid test (−), IgG (−), IgM (−), and chest CT showed abnormal lung findings consistent with the radiographic features of COVID-19 convalescence stage	Try to avoid general anesthesia with endotracheal intubation, select epidural, lumbar, paravertebral block, and intravenous or local anesthesia
Low risk	Satisfy any of the following three: 1. Nucleic acid test (−), IgG (+), IgM (−), and chest CT showed normal lung findings 2. History of SARS-CoV-2 infection, nucleic acid test (−), IgG (−), IgM (−), and chest CT showed normal lung findings 3. No history of SARS-CoV-2 infection, nucleic acid test (−), IgG (−), IgM (−), and chest CT showed abnormal lung findings	Normal surgery
Normal	No history of SARS-CoV-2 infection, nucleic acid test (−), IgG (−), IgM (−), and chest CT showed normal lung findings	

COVID-19 = coronavirus disease 2019; CT = computed tomography; IgG = immunoglobulin G; IgM = immunoglobulin M; OR = operating room; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
[a] The chest CT features of COVID-19 pneumonia infection stage included lung changes (ground-glass opacities [GGOs], consolidation, GGO plus a reticular pattern, vacuolar sign, microvascular dilation sign, a subpleural line, and a subpleural transparent line), bronchial changes (air bronchogram and bronchus distortion), and pleural changes (pleural thickening, pleural retraction sign, and pleural effusion).
[b] The chest CT features of COVID-19 pneumonia convalescence stage included lung changes (fibrotic streaks).

it was present in the body for 1 mo or even longer and then gradually decreased [20]. Our data indicated that antibody detection for hospitalized urological patients could be important as a complement to NATs for the diagnosis of suspected cases with false negative results and in dynamic surveying for the follow-up of very high- and high-risk patients [21].

The Anesthesia Patient Safety Foundation demonstrates that the highest risk of the SARS-CoV-2 virus aerosolization is during intubation and extubation during procedures that require general anesthesia [22]. The American Society of Anesthesiologists also states that laryngeal mask airway may actually increase the risk of SARS-CoV-2 virus aerosolization in the setting of high airway pressure and leakage around the mask [23]. Moreover, monitored anesthesia care, although it avoided intubation and extubation, may require the anesthesia provider to be closer to the patient's airway, and thus the provider may be at a greater risk if there is a problem requiring manual bagging or unplanned intubation [24]. In particular, through minimizing the many aerosol-generating procedures,
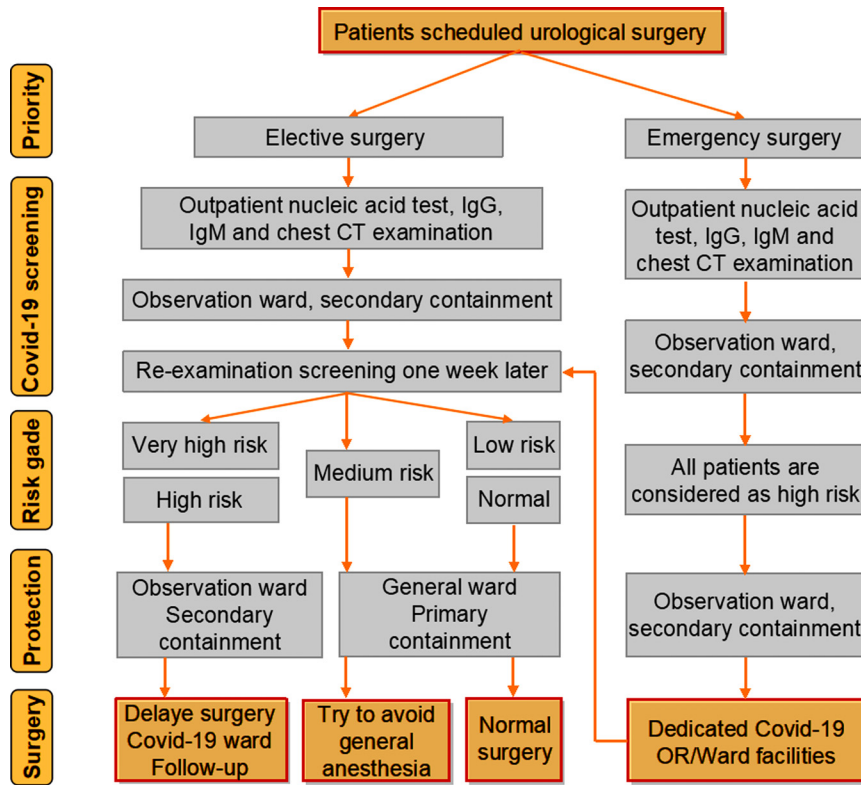
Fig. 1 – The flow chart of hospitalized urological patients' management practice after the COVID-19 pandemic in Wuhan.
COVID-19 = coronavirus disease 2019; CT = computed tomography; IgG = immunoglobulin G; IgM = immunoglobulin M; OR = operating room.

Table 5 – Risk assessment of SARS-CoV-2 transmission for 319 hospitalized urological patients after the COVID-19 pandemic in Wuhan.

Risk grade[a]	Total	Definition	Subtotal	Tongji Hospital	TCM Hospital
Very high risk	3/319 (0.94)	1	0	0	0
		2	3/319	1/172	2/147
High risk	4/319 (1.25)	1	3/319	2/172	1/147
		2	1/319	1/172	0
Intermediate risk	5/319 (1.57)	1	5/319	3/172	2/147
		2	0	0	0
Low risk	104/319 (32.6)	1	0	0	0
		2	0	0	0
		3	104/319	59/172	45/147
Normal	203/319 (63.6)	1	203/319	106/172	97/147

Data are presented as n/N (%) or n/N.
COVID-19 = coronavirus disease 2019; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
[a] Risk classification was assessed according to the definition in Table 4.

such as bag mask ventilation, open airway suctioning, and endotracheal intubation performed during general anesthesia, anesthesiologists could reduce the risk of exposure of healthcare staff and other patients to patients' respiratory secretions and perioperative viral transmission [25]. Regional block anesthesia has beneficial effects of preservation of respiratory function, to avoid SARS-CoV-2 viral aerosolization and transmission [25]. Therefore, the provision of regional block anesthesia may be the key during this COVID-19 pandemic, as it may reduce the need for general anesthesia.

Another factor to consider for endourological procedures is exposure to urine during the surgery. Most studies of NATs using urine specimens for SARS-CoV-2 have been negative [26,27]. One study in China reported that the urine of four of

58 hospitalized COVID-19 patients was detected to be SARS-CoV-2 RNA positive [28]. Out of caution, minimization of trauma and waterproofing of surgical equipment are recommended during endourological surgery to decrease the risk of urine contact transmission during the COVID-19 pandemic.

In addition, telemedicine proved a pragmatic and convenient approach to decrease the frequency of face-to-face visit and maintain appropriate patient care during the COVID-19 pandemic [12,29]. Most outpatient urology visits are not urgent. Therefore, taking full advantage of telemedicine to reduce unnecessary physical exposure is of great importance.

It should be noted that this study has some limitations. First, all the NATs were based on upper respiratory tract specimens using nasopharyngeal or oropharyngeal swab;

Table 6 – Clinical characteristics and SARS-CoV-2 parameters of seven patients with very high and high risk for transmission.

No.	Age (yr)	Gender	Urological disease	History of COVID-19	Chest CT findings	First time			1 wk later			Treatment
						Nucleic acid	IgG	IgM	Nucleic acid	IgG	IgM	
1	89	Male	Prostatic hyperplasia	No	Ground-glass opacities and fibrotic streaks in the lower right lung	–	–	+	–	–	+	Drug treatment
2	44	Female	Kidney stone	No	Ground glass density patches in the right middle lung and left lingual lobe	–	–	+	–	+	+	Drug treatment
3	63	Male	Prostate cancer	No	Ground-glass opacities and strip shadow in the upper left lung, the lobe of tongue, and the middle right lung	–	+	–	–	+	–	Active monitoring
4	47	Male	Hydronephrosis with ureteral stricture	Yes	Multiple ground-glass density patches in the lower lobes of both lungs	–	–	–	–	–	–	Nephrostomy under local anesthesia
5	53	Male	Ureteral stone	No	Ground-glass opacities in the lower lobe of the left lung and blurred patchy shadows in the left upper lobe of the lung	–	+	–	–	+	–	Double J stent placement
6	57	Male	Elevated PSA	No	Multiple ground-glass opacities of double lower lung	–	+	+	–	+	+	Active monitoring
7	67	Male	Prostatic hyperplasia	No	Ground-glass opacities and fibrotic streaks in the lingual segment of the upper lobe of the left lung and the middle lobe of the right lung	–	+	–	–	+	+	Drug treatment

COVID-19 = coronavirus disease 2019; CT = computed tomography; IgG = immunoglobulin G; IgM = immunoglobulin M; PSA = prostate specific antigen; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

Table 7 – Clinical characteristics and SARS-CoV-2 parameters of five patients with medium risk for transmission.

No.	Age (yr)	Gender	Urological disease	History of COVID-19	Chest CT findings	First time			1 wk later			Anesthesia	Surgery
						Nucleic acid	IgG	IgM	Nucleic acid	IgG	IgM		
1	59	Female	Kidney stone	No	Scattered fibrotic streaks in the right upper lung	–	+	–	–	+	–	Paravertebral block anesthesia	PCNL
2	66	Male	Prostatic hyperplasia	No	Scattered fibrotic streaks in the left lower lung	–	+	–	–	+	–	Epidural block anesthesia	TURP
3	63	Male	Prostate cancer	No	Fibrotic streaks in the lower lobes of both lungs	–	+	–	–	+	–	Combined lumbar anesthesia and epidural block	LA
4	52	Male	Ureteral stone	No	Scattered fibrotic streaks in the upper right lung and the middle left lung	–	+	–	–	+	–	Epidural block anesthesia	URS
5	53	Female	Bladder cancer	No	Fibrotic streaks in the lower lobe of the left lung	–	+	–	–	+	–	Epidural block anesthesia	TURBt

COVID-19 = coronavirus disease 2019; CT = computed tomography; IgG = immunoglobulin G; IgM = immunoglobulin M; LA = laparoscopic adrenalectomy; PCNL = percutaneous nephrolithotomy; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2; TURBt = transurethral electroresection of bladder tumor; TURP = transurethral resection of the prostate; URS = ureterolithotripsy.

the positive rate may be higher in detection using lower respiratory tract specimens, such as bronchoalveolar lavage fluid, which may yield higher sensitivity for NATs. Second, this study was limited to two centers only; it is necessary to investigate the risk of urological patients scheduled for surgery in a multicenter study with a larger sample size. Third, the longitudinal follow-up and chest CT, NATs, and antibodies should be traced for very-high- and high-risk patients.

5. Conclusions

Of the 319 patients, seven were identified with very high and high risk, which reinforced the importance of epidemic surveillance of discharged COVID-19 patients and asymptomatic infections. Our experience of risk assessment and management practice may provide a strategy to prevent SARS-CoV-2 transmission for hospitalized urological patients after the COVID-19 pandemic.

CRediT authorship contribution statement

Ejun Peng: Conceptualization, Data curation, Supervision. **Ding Xia:** Conceptualization, Data curation, Supervision. **Wenxi Gao:** Conceptualization, Data curation, Supervision. **Ying Zhan:** Methodology. **Huan Yang:** Methodology. **Xiaoqi Yang:** Methodology. **Hua Xu:** Methodology. **Xiaoling Qu:** Methodology. **Jie Sun:** Methodology. **Shaogang Wang:** Writing - review & editing. **Zhangqun Ye:** Writing - review & editing. **Kun Tang:** Conceptualization, Data curation, Writing - original draft, Funding acquisition, Supervision. **Zhiqiang Chen:** Conceptualization, Data curation, Writing - original draft, Supervision.

References

[1] World Health Organization. Coronavirus disease 2019 (COVID-19) situation report–44. March 04. www.who.int/docs/default-source/coronaviruse/situation-reports/20200304-sitrep-44-COVID-19.pdf?sfvrsn=93937f92_62020

[2] Shen N, Zhu Y, Wang X, et al. Characteristics and diagnosis rate of 5630 subjects receiving SARS-CoV-2 nucleic acid tests from Wuhan, China. JCI Insight 2020;5:e137662.

[3] Liu R, Han H, Liu F, et al. Positive rate of RT-PCR detection of SARS-CoV-2 infection in 4880 cases from one hospital in Wuhan, China, from Jan to Feb 2020. Clin Chim Acta 2020;505:172–5.

[4] Pan Y, Long L, Zhang D, et al. Potential false-negative nucleic acid testing results for severe acute respiratory syndrome coronavirus 2 from thermal inactivation of samples with low viral loads. Clin Chem 2020;66:794–801.

[5] Hu Z, Song C, Xu C, et al. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing. China Sci China Life Sci 2020;63:706–11.

[6] Mizumoto K, Kagaya K, Zarebski A, Chowell G. Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. Euro Surveill 2020;25:2000180.

[7] Peng J, Wang M, Zhang G, Lu E. Seven discharged patients turning positive again for SARS-CoV-2 on quantitative RT-PCR. Am J Infect Control 2020;48:725–6.

[8] Yao XH, He ZC, Li TY, et al. Pathological evidence for residual SARS-CoV-2 in pulmonary tissues of a ready-for-discharge patient. Cell Res 2020;30:541–3.

[9] Corman VM, Landt O, Kaiser M, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Euro Surveill 2020;25:2000045.

[10] World Health Organization. Laboratory testing for 2019 novel coronavirus (2019-nCoV) in suspected human cases. www.who.int/docs/default-source/coronaviruse/situation-reports/20200227-sitrep-38-COVID-19.pdf?sfvrsn=9f98940c_2.

[11] Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern. Lancet 2020;395:470–3.

[12] Luciani L.G., Mattevi D., Giusti G., et al. Guess who's coming to dinner: COVID-19 in a COVID-free unit. Urology. In press. http://doi.org/10.1016/j.urology.2020.05.011.

[13] Proietti S., Gaboardi F., Giusti G. Endourological Stone Management in the Era of the COVID-19. Eur Urol In press. http://doi.org/10.1016/j.eururo.2020.03.042.

[14] Nathaniel C, Sangar VK, Payne SR. A 15-year longitudinal analysis of trends in elective urological surgery—an evidence base for modernising medical careers. Ann R Coll Surg Engl 2007;89:157–61.

[15] Fang Y, Zhang H, Xie J, et al. Sensitivity of chest CT for COVID-19: comparison to RT-PCR. Radiology 2020200432.

[16] Ai T, Yang Z, Hou H, et al. Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. Radiology 2020200642.

[17] Xiang F., Wang X., He X., et al. Antibody detection and dynamic characteristics in patients with COVID-19. Clin Infect Dis. In press. http://doi.org/10.1093/cid/ciaa461.

[18] Zhao J., Yuan Q., Wang H., et al. Antibody responses to SARS-CoV-2 in patients of novel coronavirus disease 2019. Clin Infect Dis. In press. http://doi.org/10.1093/cid/ciaa344.

[19] Qu J., Wu C., Li X., et al. Profile of IgG and IgM antibodies against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Clin Infect Dis. In press. https://doi.org/10.1093/cid/ciaa489.

[20] Zhang G, Nie S, Zhang Z, Zhang Z. Longitudinal change of SARS-Cov2 antibodies in patients with COVID-19. J Infect Dis 2020;222:183–8.

[21] Long QX, Liu BZ, Deng HJ, et al. Antibody responses to SARS-CoV-2 in patients with COVID-19. Nat Med 2020;26:845–8.

[22] Anesthesia Patient Safety Foundation. Perioperative considerations for the 2019 novel coronavirus (COVID-19). https://www.apsf.org/news-updates/perioperative-considerations-for-the-2019-novel-coronavirus-covid-19/.

[23] American Society of Anesthesiologists. COVID FAQs: clinical care. www.asahq.org/about-asa/governance-and-committees/asa-committees/committee-on-occupational-health/coronavirus/clinical-faqs.

[24] Steward JE, Kitley WR, Schmidt CM, Sundaram CP. Urologic surgery and COVID-19: how the pandemic is changing the way we operate. J Endourol 2020;34:541–9.

[25] Lie SA, Wong SW, Wong LT, Wong LTGL, Chong SY. Practical considerations for performing regional anesthesia: lessons learned from the COVID-19 pandemic. Can J Anaesth 2020;67:885–92.

[26] Wolfel R, Corman VM, Guggemos W, et al. Virological assessment of hospitalized patients with COVID-2019. Nature 2020;581:465–9.

[27] Yu F., Yan L., Wang N., et al. Quantitative detection and viral load analysis of SARS-CoV-2 in infected patients. Clin Infect Dis. In press. https://doi.org/10.1093/cid/ciaa345.

[28] Ling Y, Xu SB, Lin YX, et al. Persistence and clearance of viral RNA in 2019 novel coronavirus disease rehabilitation patients. Chin Med J (Engl) 2020;133:1039–43.

[29] Luciani LG, Mattevi D, Cai T, et al. Teleurology in the time of Covid-19 pandemic: here to stay? Urology 2020;140:4–6.