

COVID-19 and Urology: A Comprehensive Review of the Literature

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Abstract

Covid-19 pandemic is the newest and biggest global health threat worldwide. Medical and surgical priorities were changed dramatically at the time of this pandemic. Postponement for all outpatient and elective activities to save facilities and resources for urgent cases and Covid-19 patients was adopted by most of hospitals in the affected countries. Over the coming weeks healthcare workers including urologists will be facing increasingly difficult challenges and consequently they should adopt sufficient protection strategies to guard against infection when dealing with COVID-19 patients. In this review we discussed the impact of Covid-19 on global health, urinary tract and uro-oncologic surgeries . Additionally, we reviewed some of the available recommendations reported on oncological surgeries practice during this pandemic.

Introduction

By the end of December 2019, a pneumonia of unknown etiology was reported in the city of Wuhan (Hubei province, China), probably related to Huanan seafood market (1). By the 1st of January 2020, the Chinese authorities closed the Huanan market and applied strict epidemiological investigations that ruled out the Severe Acute Respiratory Syndrome (SARS), the Middle East Respiratory Syndrome (MERS), influenza and avian influenza. On the 7th of January, the Chinese scientists were able to isolate and perform genome sequencing of the 2019 novel Coronavirus (2019-nCoV), that was provided to the World Health Organization (WHO) by the 12th of January 2020 (2). Within few days, other Asian countries (Thailand, Japan, and The Republic of Korea) reported the first cases of 2019-nCoV outside China; however, all the reported cases were exported from Wuhan city in China (3). Later on, the WHO named the causative virus as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-COV-2) and the resulting pneumonia as Coronavirus Disease 2019 (COVID-19) (4). On the 11th of March 2020, WHO reported that the number of confirmed cases outside China was 13-folds higher (37,364 patients) and the affected countries has increased by 3-folds (113 countries) over a period of 2-weeks, thus, they declared COVID-19 as a pandemic (5). As of the 25th of March 2020, the global number of COVID-19 patients has dramatically increased up to 414,179 patients with 18,440 COVID-19 related deaths (6). The Coronavirus disease 2019 (COVID-19) is arguably the greatest challenge facing the healthcare systems all over the world in the modern era. In these settings, several urological journals advocated special blogs (i.e. the BJU International) or webpages (i.e. COVID-19 resources webpage of the European Urology) to provide up to date information to the urologists about the COVID-19 (7,8).

What is SARS-COV-2?

The coronavirus family (known as *Coronaviridae* and belongs to the order *Nidovirales*) consists of approximately 42 viruses (9). The coronaviruses are enveloped, positive-sense and single stranded RNA viruses that are characterized by their great diversity. They can be subdivided into four different classes: alpha-coronavirus, beta-coronavirus, gamma-coronavirus, and delta-coronavirus (10). Generally, most of the coronaviruses infect different animal species; however, some of them are capable of infecting humans (mainly alpha- & beta- coronaviruses) causing mild respiratory symptoms (COV-OC43, COV-229E, COV-NL63, and COV-HKU1) accounting for 10-30% of the upper respiratory tract infections in adult patients (4,11). In 2002, the SARS-COV (a novel corona virus at that time) was responsible for the first major pandemic in the new millennium, affecting more than 8000

persons all over the world with a mortality rate of approximately 10% (12). Later in 2012, a novel coronavirus (known as MERS-COV) caused an outbreak of severe respiratory disease starting in Kingdom of Saudi Arabia with a subsequent spread to different parts of the world affecting more than 800 patients with a mortality rate of 35% (4). The SARS and MERS epidemics resulted in an increased interest in the coronavirus research (13).

SARS-COV-2 is novel virus (the third zoonotic coronavirus to infect human populations over the past 20 years) that belongs to the beta-coronaviruses and it is thought to have originated in bats as a result of the similarity between its genomic sequence and that of the bat coronavirus (HKU9-1); however, the intermediate host between the bats and human is yet to be identified (4). SARS-COV-2 is highly contagious with three main routes for transmission including human-to-human contact, aerosol transmission, and transmission by touch. The virus-containing respiratory droplets of infected personnel resulting from coughing or sneezing are considered the main source of infection as they are propelled for approximately one meter and then they can be deposited on the oral, nasal or ocular mucous membranes of a nearby person (14). Furthermore, hidden transmission can occur from asymptomatic patients (with or without normal chest computed tomography) (15). The incubation period for the SARS-COV-2 ranges from 2-14 days (16).

Based on the Chinese experience, approximately 80% of patients will suffer from mild to moderate disease, 13.8% and 6.1% will experience severe symptoms and life-threatening respiratory failure, septic shock, or multiple organ failure (17). Noteworthy, the numbers in the Italian experience was different with 24.9% and 5.0% of the patients suffering from severe symptoms and life-threatening conditions, respectively (18). Furthermore, the fatality rates in Italy was much higher than in China (7.2% versus 3.8%) (17,18). The COVID-19 patient usually presents with fever (98.6%), fatigue (69.6%), dry cough (59.4%), myalgia (34.8%), dyspnea (31.2%), and diarrhea and nausea (10.1%) (19).

Global impact

Several authorities and healthcare systems have taken unprecedented measures to contain the spread of SARS-COV-2 and to face the expected surge of COVID-19 patients (20–22). Primarily, some countries started a non-invasive temperature/symptoms screening for travelers coming from China and/or endemic areas (23). Subsequently, these measures were escalated to include extreme quarantine with closure of large cities, banning international travel, restraining citizens to their homes and school shutdowns, with some countries declaring a state of national emergency (14,17,24). Furthermore, several mass gathering events were cancelled or postponed either religious, sporting, musical or even medical

conferences (including the European Association of Urology, the American Society of Clinical Oncology and the American Association of Urology annual meetings) (22,25). More strict healthcare measures were also adopted like the suspension of all non-urgent elective surgeries (20,26), and the limitation of inpatient and outpatient services to critically ill patients while increasing the critical care capacity (7,21,26). Besides, some governments have increased the financial supplies to support the healthcare systems (27), and increased their reserves of personal protective equipment (28). Despite most of the healthcare systems aimed at improving their performance while maximizing their capacities, there is an increasing pressure on medical and paramedical personnel. This pressure may result from the health workers burnout related to the massive increase in the number of patients beyond the capacity of healthcare systems and the increased risk of infection among the medical workforce (29). The major concern facing most of the governments and healthcare systems is the absence of any reliable expectations for the duration of the current emergency and its economic, social, and medical sequelae (30). Furthermore, The current pandemic has also jeopardized the clinical researches as several ongoing clinical trials are facing obstacles, which may impact their final outcomes (31).

Effect on urinary tract

SARS-COV-2 have a specific spike protein 3-D structure that is characterized by its strong binding affinity to the angiotensin-converting enzyme 2 (ACE2) receptors. In this setting, the human cells that express ACE2 may act as a target cells for the SARS-COV-2 (32). Zou X et al (33), used a threshold of 1% ACE2-positive cells (based on the ACE2 expression in type II alveolar cells in the lung in eight individuals) to determine organs at high risk for viral invasion reporting that the heart, ileum, esophagus, urinary bladder (ACE2-positive cells in bladder urothelium 2.4%) and the kidneys (ACE2 positive cells at the proximal convoluted tubules is 4%) may be at high risk for viral invasion. This may explain the acute kidney injuries occurring in 0.1-29% of the patients with COVID-19. Furthermore, the acute kidney disease in COVID-19 patients may be explained by the sepsis or septic shock resulting in cytokines storm syndrome or by the immune-mediated kidney damage (34,35). Noteworthy, COVID-19 patients with acute kidney injury show high mortality rates (60-90%) (35). Interestingly, Ling Y et al (36), demonstrated in their study of 66 patients who had recovered from COVID-19 that the viral RNA was identified in the urine samples of 6.9% of the patients. Furthermore, they reported that the urine samples remained positive even after the throat swap turned to negative. On the contrary, Wang W et al (37), reported that SARS-COV-2 was not found in the urine specimens among their included patients.

Impact on urologic surgeries

Residency training & undergraduate students

Chan MC et al (21), discussed the impact of COVID-19 pandemic on the residency training programs and undergraduate education based on their experience in Singapore reporting that this pandemic resulted in freezing of all interhospital staff movement with residents having training in other hospitals staying there indefinitely. Furthermore, all undergraduate clinical rounds were cancelled and all the teaching activities (for residents and undergraduates) were switched to the online platforms (21). Similarly, medical training programs in the United Kingdom are entitled to be cancelled or disrupted in response to the COVID-19 pandemic; however, efforts are ongoing to ensure that these actions will not compromise the long-term needs of medical trainees (38). Similarly, we would like to raise the concern that the current pandemic with the suspension of all non-urgent elective surgeries, the delay of all residency examinations, and the cessation of the undergraduate clinical rounds will potentially have its stressful impact on residents and undergraduate students.

Kidney Transplantation

End-stage kidney disease patients (especially uraemic patients on dialysis) are at higher risk for development of infectious disease compared to general population as a result of their intrinsic fragility caused by their defective immune system (39,40). Despite the absence of any evidence of COVID-19 transmission by organ donation (41), it cannot be neglected as the virus has been isolated from the blood in approximately 15% of patients (42). In these settings, the Italian Transplant Authority released the donor management guidelines recommending nasopharyngeal swab or bronchoalveolar lavage for identifying donors with COVID-19 in highly epidemic regions with exclusion of COVID-19 positive donors (43). Similarly, the Transplantation Society recommended testing for SARS-COV-2 in donors suspected for COVID-19 in endemic areas or those with history of travel to an endemic area. Furthermore, they stated that more elective transplant patients can be deferred in an area with widespread disease (44). On the same hand, the US Food & Drug Administration recommended that the donor's travel history to endemic areas, previous contact with COVID-19 patients, and confirmed or suspicious COVID-19 within 28 days prior to the organ donation, should be considered (45). However, the shortage in testing kits and the burnout of laboratory resources in endemic areas is a major point to consider (42).

Special care should be advocated to solid organ transplant recipients as they usually under chronic immunosuppression, which render them at a higher risk of COVID-19. To the best of our knowledge there are only few case reports of COVID-19 in renal transplant recipients

(46–48). In one of the two reports, a 50-years old man with history of renal transplantation in 2016, presented initially with malaise, fever, and vomiting with rare gastrointestinal symptoms. Later on, the patient developed productive cough without dyspnea and left conjunctivitis. The authors highlighted the concern that immunocompromised patients may have atypical presentation for COVID-19 (46). In the other report, the patient presented with typical COVID-19 symptoms and was treated initially by cessation of immunosuppressant therapy, followed by reduced immunosuppressants use. The authors reported that the patient successfully recovered (47). On the contrary, Yan Tianzhong et al (48), observed the successful recovery of a COVID-19 renal transplant recipient without reduction of the immunosuppressive therapy. Moreover, two bigger case series of COVID-19 in renal transplant recipients were reported by Zhang H et al (49) (n=5) and Zhu L et al (50) (n=10). On the other hand, the safety of the transplantation team is another concern, as they are exposed to the transplant recipient who may potentially harbor higher viral loads than normal individuals (42), thus the transplantation team must be cautious in areas with wide spread community diffusion of the SARS-COV-2. In this setting, the Organ Procurement and Transplantation Network in the United States suggested following the CDC recommendations when evaluating a patient with suspicious of COVID-19 (mask the patient, place the patient in an isolation room, medical personnel must take airborne and contact precautions when contacting the patient, and informing the local authorities about the case) (51).

Oncology

Cancer patients are characterized by their higher susceptibility to infectious disease compared to general population with 3.5 folds increased risk of COVID-19 related serious events (39% versus 8%, $p=0.0008$) in the form of intensive care admission, requirement for mechanical ventilation, or death due to their immunocompromised state related to the nature of their malignancy and the anti-cancer management (chemotherapy, radiotherapy, or surgery) (52,53). Based on the Chinese experience, it is recommended to delay all elective cancer surgeries or adjuvant chemotherapy in patients with stable cancer, increase the protective measures for cancer patients or cancer survivors, and a comprehensive surveillance and/or treatment is advised in cancer patients with COVID-19 (52). On the contrary, Wang H et al (54), reported that the major risk factor for cancer patients during the COVID-19 pandemic is the inability to receive sufficient medical support, while, the worse outcomes among this group of patients is probably related to the significantly higher age of cancer patients compared to non-cancer patients (in the sample reported by Liang (52)). Similarly, Xia Y et

al (55) reported that the findings of Liang (52) are not generalizable due to the small sample size (n=18), the heterogeneity on the type of cancers great difference in the course of cancers (range 0-16 years), and the different treatment strategies.

Cancer care is an integral part of the daily urologic practice with prostate cancer, urinary bladder cancer, and renal cancer accounting for 7.1%, 3.0%, and 2.2% of all cancers, respectively (56). However, the uncared delay of onco-urologic surgeries may have an impact on the short-term progression and/or mortality rates (57). As a result of the limited availability of ventilators and anesthesiologists, and the suspension of all elective surgeries Ficarra V et al (30), divided the urological cancer surgeries into four categories; 1) non-deferrable cancer surgeries include all the procedures whose delay may negatively affect the oncological or functional outcomes like patients with bladder cancer (consider transurethral resection of bladder tumor for high risk non-muscle invasive bladder cancer, any high grade bladder cancer, or tumors more than 2cm at the time of diagnosis, while radical cystectomy and urinary diversion should be considered for muscle-invasive bladder cancer or refractory carcinoma in situ), testicular cancer (radical orchiectomy), clinical T₂₋₄ renal cancers (radical nephrectomy), high grade upper tract urothelial carcinoma (radical nephroureterectomy), high risk or locally advanced prostatic carcinoma (radical prostatectomy with pelvic lymph node dissection), or clinical >T1G3 penile cancer (partial penectomy); 2) semi-non-deferrable cancer surgeries should be consider in regions with limited diffusion of COVID-19 and include the oncologic surgeries for intermediate and high risk prostatic carcinoma patients (radical prostatectomy), low-grade and small bladder tumors (consider transurethral resection), and renal tumors cT1b (consider partial or radical nephrectomy); 3) deferrable cancer surgeries; and 4) replaceable cancer surgeries (all the other urologic malignancies can be weighed as deferrable or replicable by other treatment options) (30). Similarly, Stensland KD et al (57), reported similar recommendations for urologic oncology with two main differences than the recommendations reported by Ficarra V et al (30); 1) they recommended that most prostatectomies should be delayed (selected high-risk, all intermediate risk, and all risk prostate cancer) or offered radiation therapy based on the NCCN guidelines; and 2) they recommended adrenalectomy for adrenal tumors larger than 6 cm. On the other hand, adjuvant and neoadjuvant therapies must only be considered if there is a proven survival benefits (58). In the same setting, Nowroozi A et al. (59), demonstrated that limiting the urological surgeries to just emergencies and life-threatening conditions in Iran may potentially lead to the delay of several time-sensitive surgeries such as transurethral resection of bladder tumor (TURBT), radical cystectomy, radical nephroureterectomy, and radical

prostatectomy.

Unfortunately, there is scarce data about the urologic oncological practice during the COVID-19 pandemic. Thus, we reviewed some of the available recommendations reported for other cancers to try to formulate recommendations fitting the urologic oncology practice.

In this setting, the patient should be advised to choose the nearest medical institution that is capable of providing the sufficient care. Moreover, strict preoperative screening for cancer patients with suspicion of COVID-19 should be carried out. It is recommended that a multidisciplinary team including urologists, oncologists, respiratory disease physicians, infectious disease physicians, anesthesiologists, and infection control member should be integrated in the management of urologic cancer patients with confirmed or suspicious COVID-19. Furthermore, cancer patients with COVID-19 must be placed in isolation rooms with separate medical services postoperatively, and all the disposal medical items, body fluids must be disposed with caution. Finally, all the medical staff integrated in the management of those patients with COVID-19 should be fully protected against infection (three-level protection standards) and if possible they should be isolated for 14 days postoperatively (60–66).

Benign urologic surgeries

Most of the benign urological surgeries should be postponed till the pandemic is over including, incontinence surgeries, benign prostatic hyperplasia surgeries, reconstructive surgeries (urethral strictures), infertility & erectile dysfunction surgeries, and genitourinary prolapse (30,57).

Other urologic surgeries

Ficarra V et al (30), and Stensland KD et al (57), proposed an excellent recommendations on urologic practice during the COVID-19 pandemic. As regards the urinary tract obstruction or infection, ureteral stents or nephrostomy tubes under local anesthesia should be considered first but if not possible consider ureteral stents under general anesthesia. Furthermore, acute urinary retention can be managed through the insertion of urethral or suprapubic catheter under local anesthesia. In case of clot retention due to bladder or prostate cancer consider cystoscopic evacuation and transurethral hemostasis of the bladder or prostate cancer to avoid the need for blood transfusion. On the same hand, consider intervention only for pediatric urologic emergencies including acute torsion (scrotal exploration and orchidopexy) and genitourinary obstruction (consider Foley's catheter or suprapubic tube). Regarding patients with genitourinary trauma they recommended surgical exploration only in hemodynamically unstable patients otherwise proceed with procedures that can be performed under local

anesthesia. Finally, the authors recommended immediate intervention for patients with refractory priapism (consider shunting), scrotal abscess or Fournier's gangrene (consider drainage and debridement, respectively), and infected artificial urethral sphincter or penile prosthesis (removal of the infected device) (30,57). On the other hand, Rocco B et al (67), raised the concern that some urologists may have to deal with COVID-19 patients presenting only with fever as they may be misinterpreted as urosepsis, thus the awareness about the symptomatology and their prevalence is important for all medical personnel even those with surgical backgrounds.

Special considerations

The SARS-COV-2 is a novel virus with a limited data about its ways of transmission. Despite most of the patients were infected through the previously discussed pathways, we should not neglect other pathways as transmission like transmission during blood transfusion (68) or transmission during gastrointestinal endoscopic surgery (69). Based on the Chinese experience, 3,387 healthcare workers were infected with COVID-19 with a mortality rate of 0.6% (70). In this setting, special caution is mandatory to reduce the infection among healthcare workers caring for COVID-19 patients. Furthermore, the EAU Robotic Urology Section (ERUS) recommended that these precautions should be adopted by the urologic robotic surgeons (71).

Concerns on laparoscopic and robotic surgeries

Kwak HD et al (72), reported the presence of hepatitis B virus in the surgical smoke during the laparoscopic and robotic surgeries. Similarly, Sawchuk WS et al (73) and Gloster HMJ et al (74), demonstrated that papillomavirus was detected in the vapors resulting from laser or electrocoagulation treatment of warts. On the same hand, Johnson GK et al (75), reported that smoke resulting from surgical power instruments such as electrocautery is capable of carrying HIV virus in an in vitro study. These findings raise the concerns of aerosol infection for healthcare workers during robotic or laparoscopic surgeries. During the current pandemic, aerosol transmission of SARS-COV-2 should not be neglected as it is capable of being viable in aerosols for a duration of three hours (76). In this setting, it is recommended to use the lowest allowed intra-abdominal pressure for the pneumoperitoneum during robotic or laparoscopic surgeries to reduce the risk of aerosol infection for healthcare workers. Furthermore, the recent SAGES guidelines recommends the use of devices that are capable of filtering the aerosolized particles from the carbon dioxide produced during laparoscopic surgeries; however, these guidelines were updated to ensure that currently there is no evidence for the aerosol presence of SARS-COV-2 in the surgical smoke of laparoscopic

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surgeries but the guidelines were based on the assumptions that this novel virus may share the properties of other detected viruses (Hepatitis B, papilloma virus, or HIV) (77). Furthermore, Zheng et al (78), recommended using lower power setting of the electrocautery as the ultrasonic scalpels or electrical devices may produce large amount of surgical smoke. Additionally, adequate and complete desufflation of the pneumoperitoneum may reduce the risk of infection. Noteworthy, all the console surgeon should wear goggles or sealed visor mask with careful sterilization of the head support of the console between cases (71). Finally, the ERUS guidelines suggested that the robotic surgical procedure should be performed by an experienced robotic surgeon in order to minimize the utilization of medical resources (71).

Bowel segment utilization

Although fecal-oral transmission of the SARS-COV-2 was not reported in the literature, it is theoretically possible, where the virus was isolated and even persisted in feces after throat swaps turned negative (36). In this setting, it is recommended to keep the bowel handling to minimum (71).

Endoscopic procedure

Only one report in the literature demonstrated the presence of SARS-COV-2 in the urine specimen of 6.9% of patients (36), and there is no available evidence on urine transmission. It is recommended that endoscopic procedures and urethral catheterization should be performed with caution and the surgeons should be completely protected against infection if the patient have a suspicious or confirmed COVID-19 (71).

Conclusion

COVID-19 pandemic is the biggest challenge facing healthcare systems worldwide. In the urological fields, all elective surgeries should be deferred in regions with high caseload as a result of the limited availability of ventilators, manpower, and hospital beds, while, surgical intervention should be considered for urologic emergencies like high grade malignancies and unstable trauma patients. All healthcare workers including urologists should adopt sufficient protection strategies to guard against infection when dealing with COVID-19 patients. The current recommendations are based on the limited data available in the literature and is subject to changes.

References

1. Bogoch II, Watts A, Thomas-Bachli A, Huber C, Kraemer MUG, Khan K. Pneumonia of Unknown Etiology in Wuhan, China: Potential for International Spread Via Commercial Air Travel. *J Travel Med.* 2020 Jan 14;
2. Hui DS, I Azhar E, Madani TA, Ntoumi F, Kock R, Dar O, et al. The continuing 2019-

- nCoV epidemic threat of novel coronaviruses to global health — The latest 2019 novel coronavirus outbreak in Wuhan, China. Vol. 91, *International Journal of Infectious Diseases*. Elsevier B.V.; 2020. p. 264–6.
3. World Health Organization. Novel Coronavirus (2019-nCoV) SITUATION REPORT - 1 [Internet]. 21 January. 2020 [cited 2020 Mar 23]. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf?sfvrsn=20a99c10_4
 4. He F, Deng Y, Li W. Coronavirus Disease 2019 (COVID-19): What we know? *J Med Virol* [Internet]. 2020 Mar 14 [cited 2020 Mar 23];jmv.25766. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32170865>
 5. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report – 51 [Internet]. 11 March. 2020 [cited 2020 Mar 23]. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200311-sitrep-51-covid-19.pdf?sfvrsn=1ba62e57_10
 6. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report – 65 [Internet]. 25 March. 2020 [cited 2020 Mar 26]. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200325-sitrep-65-covid-19.pdf?sfvrsn=2b74edd8_2
 7. Covid-19 and urology - BJUI [Internet]. [cited 2020 Mar 26]. Available from: <https://www.bjuinternational.com/bjui-blog/covid-19-and-urology/>
 8. COVID-19 Resource: European Urology [Internet]. [cited 2020 Mar 26]. Available from: <https://www.europeanurology.com/covid-19-resource>
 9. Chan JFW, Lau SKP, To KKW, Cheng VCC, Woo PCY, Yue KY. Middle East Respiratory syndrome coronavirus: Another zoonotic betacoronavirus causing SARS-like disease. *Clin Microbiol Rev* [Internet]. 2015 Apr 25 [cited 2020 Mar 24];28(2):465–522. Available from: <http://cmr.asm.org/lookup/doi/10.1128/CMR.00102-14>
 10. Zumla A, W Chan JF, Azhar EI, C Hui DS, Yuen K-Y. Coronaviruses — drug discovery and therapeutic options. *Nat Publ Gr* [Internet]. 2016 [cited 2020 Mar 23]; Available from: www.nature.com/nrd
 11. Paules CI, Marston HD, Fauci AS. Coronavirus Infections-More Than Just the Common Cold. Vol. 323, *JAMA - Journal of the American Medical Association*. American Medical Association; 2020. p. 707–8.
 12. Cheng VCC, Lau SKP, Woo PCY, Kwok YY. Severe acute respiratory syndrome

- Accepted Article
- coronavirus as an agent of emerging and reemerging infection [Internet]. Vol. 20, *Clinical Microbiology Reviews*. 2007 [cited 2020 Mar 24]. p. 660–94. Available from: <http://cmr.asm.org/cgi/doi/10.1128/CMR.00023-07>
13. Woo PCY, Lau SKP, Huang Y, Yuen KY. Coronavirus diversity, phylogeny and interspecies jumping [Internet]. Vol. 234, *Experimental Biology and Medicine*. 2009 [cited 2020 Mar 24]. p. 1117–27. Available from: <http://journals.sagepub.com/doi/10.3181/0903-MR-94>
 14. Yang Y, Peng F, Wang R, Guan K, Jiang T, Xu G, et al. The deadly coronaviruses: The 2003 SARS pandemic and the 2020 novel coronavirus epidemic in China. *Journal of Autoimmunity*. Academic Press; 2020. p. 102434.
 15. Bai Y, Yao L, Wei T, Tian F, Jin DY, Chen L, et al. Presumed Asymptomatic Carrier Transmission of COVID-19. *JAMA - Journal of the American Medical Association*. American Medical Association; 2020.
 16. Zumla A, Niederman MS. The explosive epidemic outbreak of novel coronavirus disease 2019 (COVID-19) and the persistent threat of respiratory tract infectious diseases to global health security. *Curr Opin Pulm Med* [Internet]. 2020 Mar [cited 2020 Mar 25];1. Available from: <http://journals.lww.com/10.1097/MCP.0000000000000676>
 17. Kupferschmidt K, Cohen J. Can China’s COVID-19 strategy work elsewhere? *Science* [Internet]. 2020 Mar 6 [cited 2020 Mar 25];367(6482):1061–2. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32139521>
 18. Livingston E, Bucher K. Coronavirus Disease 2019 (COVID-19) in Italy. *JAMA* [Internet]. 2020 Mar 17 [cited 2020 Mar 26]; Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32181795>
 19. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical Characteristics of 138 Hospitalized Patients with 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA - J Am Med Assoc*. 2020 Mar 17;323(11):1061–9.
 20. Iacobucci G. Covid-19: all non-urgent elective surgery is suspended for at least three months in England. *BMJ* [Internet]. 2020 Mar 18 [cited 2020 Mar 23];368:m1106. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32188602>
 21. Chan M-C, Yeo SEK, Chong Y-L, Lee Y-M. Stepping Forward: Urologists’ Efforts During the COVID-19 Outbreak in Singapore. *Eur Urol* [Internet]. 2020 Mar 17 [cited 2020 Mar 23];0(0). Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32192816>
 22. McCloskey B, Zumla A, Ippolito G, Blumberg L, Arbon P, Cicero A, et al. Comment

- Mass gathering events and reducing further global spread of COVID-19: a political and public health dilemma. *Lancet* [Internet]. [cited 2020 Mar 25];0(0). Available from: <http://dx.doi.org/10.1016/S0140-6736>
23. Phelan AL, Katz R, Gostin LO. The Novel Coronavirus Originating in Wuhan, China: Challenges for Global Health Governance. Vol. 323, *JAMA - Journal of the American Medical Association*. American Medical Association; 2020. p. 709–10.
 24. Gostin LO, Hodge JG, Wiley LF. Presidential Powers and Response to COVID-19. *JAMA* [Internet]. 2020 Mar 18 [cited 2020 Mar 25]; Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32186661>
 25. Rimmer A. Covid-19: Medical conferences around the world are cancelled after US cases are linked to Massachusetts meeting. *BMJ*. 2020 Mar 13;368:m1054.
 26. Naspro R, Da Pozzo LF. Urology in the time of corona. *Nat Rev Urol* [Internet]. 2020 Mar 23 [cited 2020 Mar 25];1–3. Available from: <http://www.nature.com/articles/s41585-020-0312-1>
 27. Legido-Quigley H, Mateos-García JT, Campos VR, Gea-Sánchez M, Muntaner C, McKee M. The resilience of the Spanish health system against the COVID-19 pandemic. *Lancet Public Heal* [Internet]. 2020 [cited 2020 Mar 25];2667(20):19–20. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2468266720300608>
 28. Mahase E. Coronavirus: global stocks of protective gear are depleted, with demand at “100 times” normal level, WHO warns. *BMJ*. 2020 Feb 10;368:m543.
 29. Adams JG, Walls RM. Supporting the Health Care Workforce During the COVID-19 Global Epidemic. *JAMA* [Internet]. 2020 Mar 12 [cited 2020 Mar 23]; Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32163102>
 30. Ficarra V, Novara G, Abrate A, Bartoletti R, Crestani A, De Nunzio C, et al. Urology practice during COVID-19 pandemic. *Minerva Urol Nefrol* [Internet]. 2020 Mar 23 [cited 2020 Mar 25]; Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32202401>
 31. Pellino G, Spinelli A. How COVID-19 Outbreak Is Impacting Colorectal Cancer Patients in Italy. *Dis Colon Rectum* [Internet]. 2020 Mar 17 [cited 2020 Mar 25];1. Available from: <http://journals.lww.com/10.1097/DCR.0000000000001685>
 32. Lin L, Lu L, Cao W, Li T. Hypothesis for potential pathogenesis of SARS-CoV-2 infection—a review of immune changes in patients with viral pneumonia. *Emerg Microbes Infect* [Internet]. 2020 Mar 20 [cited 2020 Mar 25];1–14. Available from: <https://www.tandfonline.com/doi/full/10.1080/22221751.2020.1746199>
 33. Zou X, Chen K, Zou J, Han P, Hao J, Han Z. Single-cell RNA-seq data analysis on the

- receptor ACE2 expression reveals the potential risk of different human organs vulnerable to 2019-nCoV infection. [cited 2020 Mar 25]; Available from: <https://doi.org/10.1007/s11684-020-0754-0>
34. Yang XH, Sun RH, Chen DC. Diagnosis and treatment of COVID-19: acute kidney injury cannot be ignored. *Zhonghua Yi Xue Za Zhi* [Internet]. 2020 Mar 8 [cited 2020 Mar 25];100(0):E017–E017. Available from: <https://pubmed.ncbi.nlm.nih.gov/32145717> NS -
 35. Naicker S, Yang C-W, Hwang S-J, Liu B-C, Chen J-H, Jha V. The Novel Coronavirus 2019 Epidemic and Kidneys. *Kidney Int.* 2020 Mar;0(0).
 36. Ling Y, Xu S-B, Lin Y-X, Tian D, Zhu Z-Q, Dai F-H, et al. Persistence and clearance of viral RNA in 2019 novel coronavirus disease rehabilitation patients. *Chin Med J (Engl)*. 2020 Feb;1.
 37. Wang W, Xu Y, Gao R, Lu R, Han K, Wu G, et al. Detection of SARS-CoV-2 in Different Types of Clinical Specimens. *JAMA* [Internet]. 2020 Mar 11 [cited 2020 Mar 17]; Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32159775>
 38. Rimmer A. Trainees and covid-19: your questions answered. *BMJ*. 2020 Mar 13;368:m1059.
 39. Basile C, Combe C, Pizzarelli F, Covic A, Davenport A, Kanbay M, et al. Recommendations for the prevention, mitigation and containment of the emerging SARS-CoV-2 (COVID-19) pandemic in haemodialysis centres. *Nephrol Dial Transplant* [Internet]. 2020 Mar 20 [cited 2020 Mar 25]; Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32196116>
 40. Wang X, Xiao Y, Kaiyu YX, Yongwen Q, Song L, Mengxin C, et al. SARS-CoV-2 infection in renal failure patients: a potential covert source of infection Powered by Editorial Manager® and ProduXion Manager® from Aries Systems Corporation. *Eur Urol*. 2020;Accepted a.
 41. Perico L, Benigni A, Remuzzi G. Should COVID-19 Concern Nephrologists? Why and to What Extent? The Emerging Impasse of Angiotensin Blockade. *Nephron* [Internet]. 2020 Mar 23 [cited 2020 Mar 25];1–9. Available from: <https://www.karger.com/Article/FullText/507305>
 42. Kumar D, Manuel O, Natori Y, Egawa H, Grossi P, Han S-H, et al. COVID-19: A Global Transplant Perspective on Successfully Navigating a Pandemic. *Am J Transplant* [Internet]. 2020 Mar 23 [cited 2020 Mar 25]; Available from: <http://doi.wiley.com/10.1111/ajt.15876>

- Accepted Article
43. Andrea G, Daniele D, Barbara A, Davide M, Laura A, Paolo R, et al. Coronavirus Disease 2019 and Transplantation: a view from the inside. *Am J Transplant* [Internet]. 2020 Mar 17 [cited 2020 Mar 25];ajt.15853. Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1111/ajt.15853>
 44. The Transplantation Society. An Update and Guidance on 2019 Novel Coronavirus (2019-nCov) for Transplant ID Clinicians [Internet]. [cited 2020 Mar 25]. Available from: <https://tts.org/23-tid/tid-news/657-tid-update-and-guidance-on-2019-novel-coronavirus-2019-ncov-for-transplant-id>
 45. U.S. Food & Drug Administration. Important Information for Human Cell, Tissue, or Cellular or Tissue-based Product (HCT/P) Establishments Regarding the 2019 Novel Coronavirus Outbreak | FDA [Internet]. [cited 2020 Mar 25]. Available from: <https://www.fda.gov/vaccines-blood-biologics/safety-availability-biologics/important-information-human-cell-tissue-or-cellular-or-tissue-based-product-hctp-establishments>
 46. Guillen E, Pineiro GJ, Revuelta I, Rodriguez D, Bodro M, Moreno A, et al. Case report of COVID-19 in a kidney transplant recipient: Does immunosuppression alter the clinical presentation? *Am J Transplant* [Internet]. 2020 Mar 20 [cited 2020 Mar 25]; Available from: <http://doi.wiley.com/10.1111/ajt.15874>
 47. Zhu L, Xu X, Ma K, Yang J, Guan H, Chen S, et al. Successful recovery of COVID-19 pneumonia in a renal transplant recipient with long- term immunosuppression. *Am J Transplant* [Internet]. 2020 Mar 17 [cited 2020 Mar 25];ajt.15869. Available from: <https://onlinelibrary.wiley.com/doi/abs/10.1111/ajt.15869>
 48. Yan T, Wang J, Li X, Cao G, Wu X, Wang Z, et al. COVID-19 in a Kidney Transplant Patient. *Eur Urol*. 2020;Accepted A.
 49. Wang Z, Zhang H, Chen Y, Yuan Q, Xia Q, Zeng X, et al. Identification of kidney transplant recipients with COVID-19. *Eur Urol*. 2020;Accepted A.
 50. Zhu L, Gong N, Liu B, Lu X, Chen D, Chen S, et al. Coronavirus Disease COVID-2019 Pneumonia in Immunosuppressed Renal Transplant Rrecipients: A Summary of ten Confirmed Cases in Wuhan,China. *Eur Urol*. 2020;Accepted A.
 51. Organ Procurement and Transplantation Network. Information for transplant programs and OPOs regarding 2019 Novel Coronavirus - OPTN [Internet]. [cited 2020 Mar 25]. Available from: <https://optn.transplant.hrsa.gov/news/information-for-transplant-programs-and-opos-regarding-2019-novel-coronavirus/>
 52. Liang W, Guan W, Chen R, Wang W, Li J, Xu K, et al. Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China. Vol. 21, *The Lancet Oncology*.

- Lancet Publishing Group; 2020. p. 335–7.
53. Ueda M, Martins R, Hendrie PC, McDonnell T, Crews JR, Wong TL, et al. Managing Cancer Care During the COVID-19 Pandemic: Agility and Collaboration Toward a Common Goal. *JNCCN-Journal Natl Compr Cancer Netw 1 JNCCN Spec Featur* [Internet]. 2020 Mar 20 [cited 2020 Mar 25];1–4. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32197238>
 54. Wang H, Zhang L. Risk of COVID-19 for patients with cancer. *Lancet Oncol* [Internet]. 2020 [cited 2020 Mar 25];2019(20):S1470-2045(20)30149-2. Available from: <https://pubmed.ncbi.nlm.nih.gov/32142621>
 55. Xia Y, Jin R, Zhao J, Li W, Shen H. Risk of COVID-19 for cancer patients. *Lancet Oncol* [Internet]. 2020 Mar 3 [cited 2020 Mar 25];0(0). Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32142622>
 56. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2018 Nov;68(6):394–424.
 57. Stensland KD, Morgan TM, Moinzadeh A, Lee CT, Briganti A, Catto J, et al. CONSIDERATIONS IN THE TRIAGE OF UROLOGIC SURGERIES DURING THE COVID-19 PANDEMIC. *Eur Urol*. 2020;Accepted A.
 58. Sommer SG, Powles T. Advice for Medical Oncology care of Urological cancer patients during the COVID-19 pandemic-Manuscript Draft. *Eur Urol*. 2020;Accepted A.
 59. Nowroozi A, Amini E. Urology practice in the time of COVID-19. *Urol J* [Internet]. 2020 Mar 24 [cited 2020 Mar 25]; Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32207540>
 60. Luo Y, Zhong M. [Standardized diagnosis and treatment of colorectal cancer during the outbreak of novel coronavirus pneumonia in Renji hospital]. *Zhonghua Wei Chang Wai Ke Za Zhi*. 2020;23(3):E003.
 61. Yu GY, Lou Z, Zhang W. [Several suggestions of operation for colorectal cancer under the outbreak of corona virus disease 2019 in China]. *Zhonghua Wei Chang Wai Ke Za Zhi* [Internet]. 2020 Mar 25 [cited 2020 Mar 25];23(3):208–11. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32192295>
 62. Tao KX, Zhang BX, Zhang P, Zhu P, Wang GB, Chen XP. [Recommendations for general surgery clinical practice in novel coronavirus pneumonia situation]. *Zhonghua Wai Ke Za Zhi* [Internet]. 2020 Feb 14 [cited 2020 Mar 25];58(0):E001. Available

- from: <http://www.ncbi.nlm.nih.gov/pubmed/32057212>
63. Wu F, Song Y, Zeng HY, Ye F, Rong WQ, Wang LM, et al. [Discussion on diagnosis and treatment of hepatobiliary malignancies during the outbreak of novel coronavirus pneumonia]. *Zhonghua Zhong Liu Za Zhi*. 2020;42(0):E004.
64. Li Y, Qin JJ, Wang Z, Yu Y, Wen YY, Chen XK, et al. [Surgical treatment for esophageal cancer during the outbreak of COVID-19]. *Zhonghua Zhong Liu Za Zhi* [Internet]. 2020 Feb 27 [cited 2020 Mar 26];42(0):E003. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32105052>
65. Liu BL, Ma F, Wang JN, Fan Y, Mo HN, Xu BH. [Health management of breast cancer patients outside the hospital during the outbreak of 2019 novel coronavirus disease]. *Zhonghua Zhong Liu Za Zhi* [Internet]. 2020 Feb 26 [cited 2020 Mar 26];42(0):E002. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32100979>
66. Hu XH, Niu WB, Zhang JF, Li BK, Yu B, Zhang ZY, et al. [Thinking of treatment strategies for colorectal cancer patients in tumor hospitals under the background of coronavirus pneumonia]. *Zhonghua Wei Chang Wai Ke Za Zhi* [Internet]. 2020 Feb 22 [cited 2020 Mar 26];23(3):E002. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32084675>
67. Rocco B, Sighinolfi MC, Mussini C. COVID-19: importance of the awareness of clinical syndrome by urologists. *Eur Urol*. 2020;Accepted A.
68. Dodd RY, Stramer SL. COVID-19 and Blood Safety: Help with a Dilemma. *Transfus Med Rev* [Internet]. 2020 Feb 26 [cited 2020 Mar 26]; Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32147378>
69. Repici A, Maselli R, Colombo M, Gabbiadini R, Spadaccini M, Anderloni A, et al. Coronavirus (COVID-19) outbreak: what the department of endoscopy should know. *Gastrointest Endosc*. 2020 Mar;
70. Wang J, Zhou M, Liu F. Exploring the reasons for healthcare workers infected with novel coronavirus disease 2019 (COVID-19) in China. *J Hosp Infect* [Internet]. 2020 Mar 5 [cited 2020 Mar 26];0(0). Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32147406>
71. ERUS (EAU Robotic Urology Section) guidelines during COVID-19 emergency [Internet]. March. 2020 [cited 2020 Mar 26]. Available from: <https://uroweb.org/wp-content/uploads/ERUS-guidelines-for-COVID-def.pdf>
72. Kwak HD, Kim SH, Seo YS, Song KJ. Detecting hepatitis B virus in surgical smoke emitted during laparoscopic surgery. *Occup Environ Med* [Internet]. 2016 Aug 2 [cited

2020 Mar 26];73(12):857–63. Available from:

<http://www.ncbi.nlm.nih.gov/pubmed/27484956>

73. Sawchuk WS, Weber PJ, Lowy DR, Dzubow LM. Infectious papillomavirus in the vapor of warts treated with carbon dioxide laser or electrocoagulation: Detection and protection. *J Am Acad Dermatol.* 1989;21(1):41–9.
74. Gloster HM, Roenigk RK. Risk of acquiring human papillomavirus from the plume produced by the carbon dioxide laser in the treatment of warts. *J Am Acad Dermatol.* 1995;32(3):436–41.
75. Johnson GK, Robinson WS. Human immunodeficiency virus- 1 (HIV- 1) in the vapors of surgical power instruments. *J Med Virol.* 1991;33(1):47–50.
76. van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *N Engl J Med [Internet].* 2020 Mar 17 [cited 2020 Mar 26];NEJMc2004973. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/32182409>
77. SAGES Recommendations Regarding Surgical Response to COVID-19 Crisis - SAGES [Internet]. [cited 2020 Mar 26]. Available from: <https://www.sages.org/recommendations-surgical-response-covid-19/#update>
78. Zheng MH, Boni L, Facs MD, Fingerhut A. Minimally invasive surgery and the novel coronavirus outbreak: lessons learned in China and Italy. *Ann Surg.* 2020;Article in.