Zatajivanje srca u 2020.

Heart Failure in 2020

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Zatajivanje srca jedna je od najznačajnijih bolesti zbog velikog morbiditeta i mortaliteta, premda postoje brojni načini liječenja koji se stalno usavršavaju. Više zahvaća starije dobne skupine, a, kako je svjetska populacija sve starija, globalni je problem. S druge strane, mnoge bolesti, posebice kardiološke, mogu se, u nekoj fazi, očitovati zatajivanjem srca (ZS).

Koliko god se nama u struci čini da nam je problematika zatajivanja srca poznata, još uvijek se možemo iznenaditi nekim (novim) podatcima. Posljednjih mjeseci svjedoci smo pandemije virusne bolesti COVID-19 (COVID), koja nam je svima promijenila živote, oboljelo je mnogo ljudi, a za mnoge je završila smrtnim ishodom. Infekcija koronavirusom primarno zahvaća respiracijski sustav, no, kad se bolest proširi, različitim mehanizmima, može utjecati na cijeli organizam, a jedna od manifestacija bolesti, posebice u terminalnoj fazi, zna biti i ZS. Valja napomenuti da oko 80 % bolesnika može imati blage ili nikakve simptome i biti prenosilac bolesti. Pandemija COVID-a suočava nas s izazovima, uči i upozorava na sadašnje i buduće probleme sa starim i novim infekcijama i bolestima.

Europsko kardiološko društvo i Europsko društvo za zatajivanje srca, s radnim skupinama, kontinuirano razvijaju i provode brojne aktivnosti, uz smjernice, kongrese, tečajeve i sastanke, kako bi se u konačnici poboljšala prognoza bolesnika sa zatajivanjem srca, u čemu sudjeluje i Hrvatsko kardiološko društvo. Izdvajamo Registar za zatajivanje srca (*Heart Failure III Registry*), ATLAS projekt (s epidemiološkim podatcima pojedinih zemalja), Tjedan svjesnosti o zatajivanju srca (ove godine 4. do 10. svibnja), Inicijativu o zbrinjavanju bolesnika sa ZS-om kod obiteljskih liječnika uz pomoć specijaliziranih medicinskih sestara, Telemedicinska potpora (što je posebice korisno u doba pandemije). U tekstu koji slijedi

Heart failure represents one of the most significant diseases due to its high morbidity and mortality, despite the availability of various treatment methods that are being continuously improved. It is more common in older populations, and with the aging of the population it has become a growing global issue. On the other hand, many diseases, especially heart diseases, can manifest as heart failure (HF).

Although those of us who work in the field might feel that the issues surrounding HF are well-known, we can still be surprised by (new) data. Over the last few months, we have witnessed the rise of the COVID-19 (COVID) virus pandemic, that has changed all of our lives and affected many people, in many cases with a lethal outcome. COVID infection primarily affects the respiratory system, but once it has spread it can influence the whole organism via different mechanisms, and HF can also be one of its manifestations, especially in the terminal phase. It should be noted that as many as 80% of patients can have mild or no symptoms while still transmitting the disease. The COVID pandemic has made us face new challenges and taught us or warned us of current problems or of issues that will arise in the near future with regard to both new and previously known infections and diseases.

The working groups of the European Society of Cardiology and Heart Failure Association are continuously developing and implementing numerous activities in addition to providing guidelines and organizing congresses, trainings, and meetings, with the ultimate goal of improving the prognosis of patients with heart failure, and the Croatian Cardiac Society is part of this process. Notably, this participation includes the Heart Failure III Registry, the ATLAS project (with epidemiological data from individual countries), the Heart Failure Awareness Week

donosimo osvrt na liječenje akutnog i kroničnog ZS-a u doba COVID-19 pandemije.

Smjernice Europskoga kardiološkog društva za dijagnozu i liječenje kardiovaskularnih bolesti tijekom COVID-19 pandemije s osvrtom na zatajivanje srca

Bolesnici s komorbiditetima češće obolijevaju, uz teži oblik bolesti i veću smrtnost, posebice ako je riječ o kardiovaskularnim (KV), respiratornim, bubrežnim, malignim bolestima, dijabetesu, arterijskoj hipertenziji[1]. U jednom istraživanju (n = 8910) pratili su se oboljeli od COVID-a s obzirom na komorbiditete. Smrtnost je iznosila 5,8%, a rizik je bio posebno vezan uz stariju dobnu skupinu (>65 godina, 10 % : 5,8 %), koronarnu bolest srca (CAD, 10,2 % : 5,2 %), zatajivanje srca (15,3 % : 5,6 %), kroničnu opstruktivnu bolest pluća (14,2 % : 5,6 %), aritmije (11,5 % : 5,6 %) i pušenje (9,4 % : 5,6 %). KV bolesti su znatno povećavale smrtnost[2]. U metaanalizi 6 studija arterijska hipertenzija i KV bolesti bile su prisutne u 17,1 % hospitaliziranih zbog COVID-a, što je rizik od teže kliničke slike povećavalo do 3 puta[3].

Zahvaćanje srca uobičajeno se prezentira ozljedom i popuštanjem srca, aritmijama, zastojem srca. U zaraženih mogu prevladavati različiti znakovi infekcije (povišena temperatura, bolovi u mišićima i zglobovima, grlobolja, glavobolja, malaksalost, promjene kože, promjene osjeta okusa i mirisa, poremećaji probavnog i urinarnog sustava), često smetnje s disanjem i pritisak u prsištu, što zna sličiti srčanom udaru. Za postavljanje dijagnoze potrebno je koristiti se svim poznatim kliničkim metodama. Ako se obavi koronarografija, uobičajeno je uredna. U studiji oboljelih od COVID-a iz Kine (1/2020.; 552 bolnice, n = 1099, prosjek inkubacije – 4 dana, febrilnost – 43%, limfocitopenija – 8 3,2 %, tipične promjene na CT-u pluća 56 %), teži oblik bolesti razvilo je 6,1% bolesnika (5 % je primljeno u intenzivnu jedinicu, 2,3 % je stavljeno na respirator, a 1,4 % je umrlo)[4]. Petina oboljelih ima znakove oštećenja srčanog mišića i tada je smrtnost višestruko veća. U preminulih srce može biti zahvaćeno u oko 40 % slučajeva, 12 % umrlih nije imalo prethodne KV bolesti, dok je 25 – 50 % oboljelih od upale pluća imalo komorbiditete.

Bolesnici s infekcijom koronavirusom mogu dobiti novu KV bolest ili se pogoršava postojeća (CAD, kardiomiopatije, srčana insuficijencija raznih uzroka). Zatajivanje srca zna biti posljedica akutnoga virusnog miokarditisa i citokinske oluje, ali i rezultat pogoršanja kroničnog ZS-a. Visoki kardiometabolički zahtjevi u infekciji potiču prekomjeran srčani rad, dok citokini mogu potencirati šok i promjenu cirkulacije, uključujući i koronarne žile, uz stvaranje mikrotromba. Respiratorne infekcije praćene hipoksijom stvaraju veću sklonost smrtnom ishodu. Prosječno se u trećine težih bolesnika može razviti ZS.

Akutno zatajivanje srca

Akutno zatajivanje srca dio je komplikacija kliničkog tijeka infekcije, posebice težih. U podlozi mogu biti akutna ishemija miokarda, infarkt, upala/miokarditis, stresom inducirana kardiomiopatija, tahiaritmija, ARDS, akutna ozljeda bubrega i hipervolemija.

COVID-19 pneumonija vodi u pogoršanje hipoksemijom, dehidracijom i hipoperfuzijom. Klinička slika, komorbiditeti,

(this year from May 4 to May 10), and an initiative for general practitioner patient care for patients with HF with the help of specialized medical nurses, and telemedicine support (which was especially useful during the pandemic). In the rest of this article, we will provide a review of the treatment of acute and chronic HF during the COVID-19 pandemic.

Guidelines of the European Society of Cardiology for the diagnosis and treatment of cardiovascular diseases during the COVID-19 pandemic in relation to heart failure

Patients with comorbidities are infected by COVID more often with a higher disease severity and mortality, especially if the comorbidity involves cardiovascular (CV), respiratory, renal, or malignant diseases, diabetes, and arterial hypertension[1]. One study (n=8910) followed patients with COVID based on comorbidities. The mortality was 5.8%, and the risk was especially pronounced in the older age group (>65, 10%: 5.8%), in coronary artery disease (CAD, 10.2%: 5.2%), heart failure (15.3%: 5.6%), chronic obstructive pulmonary disease (COPD, 14,2%: 5,6%), arrhythmia (11.5%: 5.6%), and smoking (9.4%: 5.6%). CV diseases significantly increased mortality[2]. In a meta-analysis of 6 studies, hypertension and CV diseases were present in 17.1% of those hospitalized for COVID, with up to 3 times higher risk of higher disease severity[3].

COVID affecting the heart usually manifests as cardiac damage and heart failure, arrhythmia, and cardiac arrest. Different signs of infection can be prevalent in patients with COVID (high fever, muscle and joint pain, sore throat, headache, fatigue, skin changes, smell and taste disorders, and disorders of the digestive and urinary systems), and breathing problems accompanied by chest pain are common, which can resemble myocardial infarction. All known clinical methods must be used to establish a diagnosis. If performed, coronarography is usually normal. In a study on patients with COVID from China (1/2020; 552 hospitals, n=1099, average incubation – 4 dana, febrility 43%, lymphocytopenia 83.2%, typical changes observed on lung CT 56%), the severe form of the disease was observed in 6.1% of patients (5% were admitted to intensive care, 2.3% were placed on a respirator, and 1.4% died)[4]. A fifth of the infected had signs of myocardial damage, in which case the mortality rate was several times higher. In the deceased, the heart was affected in about 40% of cases, 12% did not have prior CV diseases, whereas 25-50% of patients with pneumonia had comorbidities.

Patients with COVID-19 infection can develop a new CV disease or present with progression of an existing disease (CAD, cardiomyopathies, various form of HF). Heart failure can be the consequence of acute viral myocarditis and a "cytokine storm", but also the result of exacerbation of chronic HF. The high cardiometabolic burden during infection causes overwork of the heart, while cytokines can exacerbate shock and circulation changes, including the coronary vessels and microthrombosis. Respiratory infections accompanied by hypoxia lead to a higher incidence of mortal outcomes. Approximately one third of patients with the severe form of the infection can develop HF.

Acute heart failure

Acute heart failure is one of the possible complications in the clinical course of COVID infection, especially in more severe cases. The underlining condition can be acute myocardial ischemia, infarction, inflammation/myocarditis, stress-induced

slikovne metode i povećani natriuretski peptidi (NP) mogu upućivati na ZS. Za dijagnostiku je važan transtorakalni ultrazvuk (TTE) uz krevet (treba paziti da se infekcija ne prenese na osoblje i uređaje).

Podatci su o akutnom ZS-u uz infekciju koronavirusom rijetki. Prema jednom izvještaju u 23 % svih hospitaliziranih razvija se ZS; ZS je znatno zastupljena dijagnoza pri smrtnim ishodima u usporedbi s onima koji su preživjeli (52 % prema 12 %, P< 0.0001)[5].

Nekoliko je mehanizama kojima se razvija akutno ZS u bolesti COVID-19, poput:

1) akutna ozljeda miokarda (promjene troponina, EKG-a, TTE) pojavljuje se u 8 % bolesnika[3]. Uzroci mogu biti ishemija, infarkt, miokarditis. U težoj infekciji, ozljeda miokarda bilježi se u 22,2 – 31 %[6]. Metaanaliza četiriju studija (n = 341) opisuje da je u bolesnika s teškom infekcijom, troponin mnogo veći pri prijmu, ostaje viši u onih koji nisu preživjeli, a povećava se pogoršanjem bolesti[5]. ZS je češći u bolesnika s akutnom ozljedom miokarda (14,6 % prema 1,5 %) uz povećanje vrijednosti NT-proBNP-a[7];

2) prateće bolesti mogu pridonijeti razvoju ZS-a (kao što su ARDS, hipoksemija, akutna ozljeda bubrega, hipovolemija, stresom inducirana kardiomiopatija, sustavna inflamacijska aktivacija – „citokinska oluja", teška infekcija uz multiorgansku disfunkciju);

3) aritmija može voditi do pogoršanja funkcije srca. Bilježi se u 16,7 % svih hospitaliziranih bolesnika s COVID-om i u 44,4 % onih koji su zahtijevali intenzivnu skrb[6].

Ograničeni podatci opisuju da infekcija sa SARS-CoV-2 zna uzrokovati fulminantni miokarditis. Na dijagnozu se može posumnjati kod akutnog početka prsnog bola, promjena u EKG-u, aritmija i hemodinamske nestabilnosti. Obično je prisutna dilatacija lijeve klijetke (LV) uz globalnu hipokontraktilnost, znatno povećanje troponina i NP-a, bez signifikantnih promjena koronarnih arterija. Sumnja na miokarditis trebala bi se pojaviti u bolesnika s COVID-om 19 i akutnim ZS-om. Oslikavanje MSCT koronarografijom poželjno je primijeniti kad želimo isključiti prateću CAD. Magnetna rezonancija (MR) može se upotrebljavati za dodatnu dijagnostiku. Endomiokardijalna biopsija ne preporučuje se u bolesnika s COVID-om. Točan mehanizam ovakvog miokarditisa nije jasan.[8]

Kronično zatajivanje srca

Rizik od infekcije koronavirusom (COVID-19) može biti visok u bolesnika sa ZS-om, uz stariju životnu dob i komorbiditete. Za dijagnostiku se primjenjuje niz pretraga: mjerenje temperature (nekontaktnim uređajima), EKG (aritmije, miokardijalna ishemija, miokarditis), RTG prsnog koša (kardiomegalija, COVID-19 pneumonija) i laboratorijski nalazi (viša sedimentacija, fibrinogen, CRP i limfocitopenija) mogu pomoći u dijagnozi. Zbog male RTG senzitivnosti katkad se primjenjuje MSCT pluća kako bi se otkrila pneumonija. TTE je vrlo važan da bi se prikazala disfunkcija LV-a i uočio miokarditis. U svemu je bitno spriječiti prijenos virusa. Bolesnici s kroničnim ZS-om trebaju se držati zaštitnih mjera (maska, rukavice, higijena ruku, socijalna distancija, dezinficijensi, samoizolacija), a u stabilnoj fazi bolje je izbjeći kontrole u bolnici. Koliko je moguće, potrebno je koristiti se telemedicinom (internetom, telefonom). Ona pomaže manjoj transmisiji virusa pri praćenju

cardiomyopathy, tachyarrhythmia, acute respiratory distress syndrome (ARDS), acute kidney injury, and hypervolemia.

COVID-induced pneumonia leads to deterioration of the patient's condition due to hypoxemia, dehydration, and hypoperfusion. The patient's clinical presentation, comorbidities, imaging methods, and elevated natriuretic peptides (NP) can indicate HF. Application of a bedside transthoracic echocardiogram (TTE) is important for the diagnosis (care should be taken not to transmit the infection to the staff and device).

Data on acute HF with COVID infection are lacking. In one report, 23% of all hospitalized patients developed HF, and HF was a significantly prevalent diagnosis in mortal outcomes in comparison with those who survived the infection (52% vs. 12%, P< 0.0001)[5].

There are several mechanisms that cause the development of acute HF in COVID infection, such as:

1) Acute myocardial injury (changes in troponin levels, ECG, TTE) manifests in 8% of patients[3]. The causes can be ischemia, infarction, or myocarditis. In severe infections, damage to the myocardium was reported in 22.2-31.0% of patients[6]. A meta-analysis of 4 studies (n=341) reported that troponin was already significantly elevated on hospital admission in patients with severe infection, that it remained higher in those who survived the infection, and that troponin levels increased as the disease became more severe[5]. HF was more common in patients with acute myocardial damage (14.6% vs. 1.5%), with elevation of NT-proBNP levels[7].

2) Comorbid diseases can contribute to the development of HF (such as acute respiratory distress syndrome, hypoxemia, acute kidney injury, hypovolemia, stress-induced cardiomyopathy, systemic inflammatory activation – a "cytokine storm", or severe infection with multi-organ dysfunction).

3) Arrhythmia can lead to deterioration of heart function. It has been reported in 16.7% of all hospitalized COVID patients and in 44.4% of those who required intensive care[6].

The limited data we have indicate that SARS-CoV-2 infection can lead to fulminant myocarditis. This diagnosis can be suspected in case of acute onset of chest pain, ECG changes, arrhythmia, and hemodynamic instability. Dilatation of the left ventricle (LV) can usually be observed, along with global hypocontractility, significantly elevated troponin and NP values, but with no significant changes in the coronary arteries. Myocarditis should also be suspected in patients with COVID-19 and HF. Imaging using MSCT coronarography is desirable when we want to exclude CAD comorbidity. Magnetic resonance imaging (MR) can be used as an additional diagnostic tool. Endomyocardial biopsy is not recommended in patients with COVID. The exact mechanism of this myocarditis is still unclear[8].

Chronic heart failure

Risk of COVID-19 infection can be high in patients with HF, as well as those at an advanced age and with comorbidities. A number of tests are used in diagnosis: body temperature measurement (with non-contact devices), ECG (arrhythmia, myocardial ischemia, myocarditis), chest X-ray (cardiomegaly, COVID-induced pneumonia), and laboratory tests (elevated erythrocyte sedimentation rate, fibrinogen, CRP, and lymphocytopenia) can facilitate establishment of the diagnosis. Due to low chest X-ray sensitivity, chest MSCT scan is used to discover pneumonia. TTE is very important to show LV dysfunction and spot myocarditis. During all of the above, it is important to prevent virus transmission. Patients with chronic HF

stabilnih bolesnika. Preporučuje se potpora psihologa i dostava lijekova kući.

SARS-CoV-2 koristi se ACE2 receptorima za ulazak u stanicu, tako da neki podatci navode da angiotenzin receptor blokatori (ARB) i inhibitori angiotenzin konvertirajućeg enzima (ACEi) mogu povećati broj ACE2 receptora, što hipotetski povećava sklonost infekciji[9]. Istraživanje među 12 bolesnika s COVID-om 19 i ARDS-om pokazuje da se plazma Ang II znatno povećava uz virusnu infekciju i ozljedu pluća[10]. Time liječenje ARB grupom lijekova može imati povoljan učinak na suzbijanje Ang II posredovane ozljede pluća. Dosad dostupni podatci upućuju na to da terapiju u kroničnih bolesnika sa ZS-om preporučenu smjernicama (ACEi, ARB, beta blokatori-BB, sakubitril/valsartan, antagonisti mineralokortikoidnih receptora-MRA) treba nastaviti neovisno o COVID-u[2,11]. Prekidanje kronične terapije može uzrokovati pogoršanje ZS-a[12]. Očekuju se daljnja istraživanja o ulozi ACEi/ARB u ovoj bolesti.

Bolesnici s LVAD-om, kao i oni s transplantacijom posebno su osjetljivi na infekcije, pa bi trebalo striktno provoditi preventivne mjere prijenosa virusa. Malo je publikacija o oboljelima s transplantacijom uz COVID-19; dostupne su neke uz zarazu SARS-om i MERS-om[13-16].

should adhere to protective measures (masks, medical gloves, hand hygiene, social distancing, disinfectants, self-isolation), and hospital checkups should be avoided during the stable phase. Telemedicine (internet, phone) should be used as much as possible. This helps reduce virus transmission while monitoring stable patients. Support from psychologists and home delivery of medication is recommended.

SARS-CoV-2 uses ACE2 receptors to enter the cell, and some data indicate that angiotensin receptor blockers (ARB) and angiotensin-converting-enzyme inhibitors (ACE inhibitors) can increase the number of ACE2 receptors, which might hypothetically increase susceptibility to infection[9]. A study on 12 patients with COVID-19 infection and ARDS showed that plasma angiotensin II was significantly increased with viral infection and damage to the lungs[10]. Therefore, treatment with the ARB group of medications can have a beneficial effect on suppressing angiotensin II-mediated lung damage. Data available so far indicates that treatment in chronic patients with HF according to guideline recommendations (ACE inhibitors, ARB, beta-blockers, sacubitril/valsartan, aldosterone receptor antagonists) should be continued regardless of COVID infection[2,11]. Termination of chronic therapy can lead to HF deterioration[12]. Further research on the role of ACE inhibitors and ARB in this disease is expected.

Patients with a left ventricular assist device (LVAD) and with heart transplants are especially susceptible to infections, and strict adherence to preventive measures against virus transmission is necessary. There have been few publications on transplant patients with COVID-19 infection; some studies with SARS and MERS infection are available[13-16].

LITERATURE

1 European Society of Cardiology. ESC Guidance for the Diagnosis and Management of CV Disease during the COVID-19 Pandemic. Available from: https://www.escardio.org/static_file/Escardio/Education-General/Topic%20pages/Covid-19/ESC%20Guidance%20Document/ESC-Guidance-COVID-19-Pandemic.pdf (May 20, 2020).

2. Mehra MR, Desai SS, Kuy S, Henry TD, Patel AN. Cardiovascular Disease, Drug Therapy, and Mortality in Covid-19. N Engl J Med. 2020 May 1:NEJMoa2007621. Epub ahead of print. https://doi.org/10.1056/NEJMoa2007621

3. Li B, Yang J, Zhao F, Zhi L, Wang X, Liu L, et al. Prevalence and impact of cardiovascular metabolic diseases on COVID-19 in China. Clin Res Cardiol. 2020 May;109(5):531-538. https://doi.org/10.1007/s00392-020-01626-9

4. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al; China Medical Treatment Expert Group for Covid-19. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med. 2020 Apr 30;382(18):1708-1720. https://doi.org/10.1056/NEJMoa2002032

5. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet. 2020 Mar 28;395(10229):1054-1062. https://doi.org/10.1016/S0140-6736(20)30566-3

6. 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. 2020 Feb 7;323(11):1061-9. https://doi.org/10.1001/jama.2020.1585

7. Shi S, Qin M, Shen B, Cai Y, Liu T, Yang F, et al. Association of Cardiac Injury With Mortality in Hospitalized Patients With COVID-19 in Wuhan, China. JAMA Cardiol. 2020 Mar 25:e200950. https://doi.org/10.1001/jamacardio.2020.0950

8. Hu H, Ma F, Wei X, Fang Y. Coronavirus fulminant myocarditis saved with glucocorticoid and human immunoglobulin. Eur Heart J. 2020 Mar 16:ehaa190. Epub ahead of print. https://doi.org/10.1093/eurheartj/ehaa190

9. Furuhashi M, Moniwa N, Mita T, Fuseya T, Ishimura S, Ohno K, et al. Urinary angiotensin-converting enzyme 2 in hypertensive patients may be increased by olmesartan, an angiotensin II receptor blocker. Am J Hypertens. 2015 Jan;28(1):15-21. https://doi.org/10.1093/ajh/hpu086

10. Liu Y, Yang Y, Zhang C, Huang F, Wang F, Yuan J, et al. Clinical and biochemical indexes from 2019-nCoV infected patients linked to viral loads and lung injury. Sci China Life Sci. 2020 Mar;63(3):364-374. https://doi.org/10.1007/s11427-020-1643-8

11. Seferovic PM, Ponikowski P, Anker SD, Bauersachs J, Chioncel O, Cleland JGF, et al. Clinical practice update on heart failure 2019: pharmacotherapy, procedures, devices and patient management. An expert consensus meeting report of the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail. 2019 Oct;21(10):1169-1186. https://doi.org/10.1002/ejhf.1531

12. Halliday BP, Wassall R, Lota AS, Khalique Z, Gregson J, Newsome S, et al. Withdrawal of pharmacological treatment for heart failure in patients with recovered dilated cardiomyopathy (TRED-HF): an open-label, pilot, randomised trial. Lancet. 2019 Jan 5;393(10166):61-73. https://doi.org/10.1016/S0140-6736(18)32484-X

13. Kumar D, Tellier R, Draker R, Levy G, Humar A. Severe Acute Respiratory Syndrome (SARS) in a liver transplant recipient and guidelines for donor SARS screening. Am J Transplant. 2003 Aug;3(8):977-81. https://doi.org/10.1034/j.1600-6143.2003.00197.x

14. AlGhamdi M, Mushtaq F, Awn N, Shalhoub S. MERS CoV infection in two renal transplant recipients: case report. Am J Transplant. 2015 Apr;15(4):1101-4. https://doi.org/10.1111/ajt.13085

15. Li F, Cai J, Dong N. First cases of COVID-19 in heart transplantation from China. J Heart Lung Transplant. 2020 May;39(5):496-497. https://doi.org/10.1016/j.healun.2020.03.006

16. Ren ZL, Hu R, Wang ZW, Zhang M, Ruan YL, Wu ZY, et al. Epidemiologic and clinical characteristics of heart transplant recipients during the 2019 coronavirus outbreak in Wuhan, China: A descriptive survey report. J Heart Lung Transplant. 2020 May;39(5):412-417. https://doi.org/10.1016/j.healun.2020.03.008