A Couple with Different Symptoms after Simultaneously 2019-nCoV Infected

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Case Report

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Abstract

Background 2019-nCoV has posed a significant threat to human health since the epidemic began. So far, there is no definite safe and effective drug treatment. Proper management can help prevent mild patients from becoming severe. We report a couple with different symptoms after simultaneously infected by the same source of 2019-nCoV and analyze the changes in the diagnosis and treatment process.

Case presentation We report a couple with different symptoms after simultaneously infected by the same source of 2019-nCoV in Shandong, China—describe their clinical course—characteristics and detection results in detail, and analyze the changes in the diagnosis and treatment process. The wife was mainly affected by respiratory system and had ever experienced high fever for several days. The husband's condition is lighter than his wife—mainly manifested as digestive tract symptoms—but it took longer than his wife for the nucleic acid of nasopharynx swab for 2019-nCoV to turn negative.

Conclusions In the course of the disease both of the couple had hypokalemia which was easy to be corrected. CRP and ESR were consistent with the changes of the disease during the 2019-nCoV infection, which were good indicators to reflect the severity and development of the disease. Two months after discharge, both of them showed negative IgM antibody and positive IgG antibody.

Background

The novel coronavirus 2019 (2019-nCoV), named by the world health organization (WHO), is now named SARS-CoV-2 by the international committee on the classification of viruses (ICTV)¹. The appropriate treatment measures are also recommended by WHO based on the severity of the disease². Progress is also being made in the management of mild to moderate patients³. Mild patients generally do not need hospital intervention, isolation and symptomatic treatment such as administration of antipyretics are suggested². Proper management of complications will help prevent the development of mild to moderate patients from becoming severe. We report a couple with the same age of mild to moderate SARS-CoV-2 infection that occurred after contact with the same new SARS-CoV-2 patient at the same time. Their onset time was one day different, the clinical symptoms and course of disease were not the same, and some similar details in the process of the disease also need to be paid attention to.

Case Presentation

On February 4, 2020, an elderly couple who were both 62 years old presented to the fever clinic of Qingdao municipal hospital in Qingdao, Shandong province, China—with masks on their faces. The husband coughed for five days and had fever four days ago. The wife had a fever for three days. They told their history of epidemiology, on January 26, the husband drove back to his hometown Weifang with his wife, where they had a close contact with their relative in driving and eating together. After being told by telephone that the relative had just been diagnosed with novel coronavirus infection, as well as the

state's report on the 2019-nCoV, attention to isolation, etc., they immediately went to the fever clinic of the hospital considering the possibility of novel coronavirus infection.

The diagnosis of the two patients met the Chinese criteria⁵ for suspected diagnosis of 2019-nCoV in terms of epidemiological history, fever (respiratory symptoms) and chest CT findings at that time, and they were admitted to the hospital and quarantined. It was subsequently confirmed by 2019-nCoV nucleic acid test.

The husband

The husband developed fever at night on January 31, with the highest body temperature of 38.6°C, accompanied by chills, cough, abdominal discomfort, nausea, diarrhea 2–3 times a day, the stools were watery and mushy, no vomiting, no phlegm at the beginning, and white phlegm appeared after 2 days. On February 2, he went to a nearby hospital for treatment. Chest computed tomography (CT) showed that there was a very small light flake shadow in the right lung while blood routine and C reactive protein (CRP) was checked. Considering the possibility of pneumonia, he was given oseltamivir, levofloxacin, Ibuprofen Tablets and traditional Chinese medicine orally. The next day his temperature dropped.

He had previously diagnosed unstable angina pectoris, which was easy to attack in winter when he was tired, and had no symptoms for nearly half a year. The patient had no special hobbies and never smoke. The physical examination revealed a body temperature of 36.2 °C, blood pressure of 134/88 mmHg, pulse of 105 beats per minute, respiratory rate of 20 breaths per minute. The patient was then given blood routine and CRP test (Fig. 1), which showed normal counts of leukocytes and lymphocytes, and chest CT examination (Table 1), which still showed small and light shadow of the right lung. After a multidisciplinary consultation in the hospital, including respiratory department, laboratory, imaging department, ICU, and hospital sensory department, it was concluded that the patient was a suspected case of 2019-nCoV according to the history of close contact with the confirmed patient and chest imaging changes. The decision was made to isolate the couple in a single room in the fever observation ward for clinical observation, and the CDC was informed to take oropharyngeal and nasopharyngeal swabs and sputum for nucleic acid testing. Medical and cleaning personnel were notified to follow the procedures of patient contact, blood collection and ward rounds in accordance with the standard of complete protection⁵.

On February 5 (the second day of admission, day 6 of illness), the husband had no obvious fever, relieved cough, a small amount of mucous sputum, no aggravation of abdominal discomfort and diarrhea, the heart rate dropped to 81 beats/min, blood oxygen saturation could reach 99% while the patient was breathing ambient air, and other vital signs were stable. Administration of levofloxacin to patients; The CDC reported the positive nucleic acid test for 2019-nCoV at 10 p.m.

From days 3 through 5 of hospitalization, the patient still had cough and diarrhea, and his vital signs were stable. The chest CT examination showed no significant change in the pulmonary condition. There was no obvious abnormality in blood routine examination, CRP and biochemical combination (Table 1).

Ribavirin, oseltamivir, montmorillonite powder, live bacillus subtilis, compound methoxyphenamine capsules, a recombinant human interferon α 1b atomization inhalation therapy and traditional Chinese medicine therapy were used successively. The couple were separated in isolated rooms to avoid cross-infection.

On the hospital day 6 no special changes in the patient's symptoms and signs. Biochemical tests showed that bilirubin increased, blood potassium decreased, leukocyte increased, CRP increased (Table 1). The patient was given oral and intravenous potassium supplementation, levofloxacin was stopped, ceftazidime was used for anti infection treatment, and magnesium isoglycyrrhizinate injection and oral ursodeoxycholic acid were used for liver protection.

On the hospital day 7 and 8, bilirubin was still elevated by biochemical test, serum potassium was improved, blood routine was normal, CRP was lower than before, and the patient's symptoms and signs were stable. The chest CT scan showed no significant change compared with that of 2020-02-07. The multidisciplinary consultation suggested that ribavirin should be discontinued, iopinavir/ritonavir should be added, and traditional Chinese medicine decoction should be continued. Stop using other drugs and give the liver protection treatment such as ademetionine 1,4 - butanedisulfonate for injection.

On the 8 day of hospitalization, according to the guidelines of the Municipal Health Commission, the couple were transferred to the Chest Hospital where the confirmed patients were treated centrally by the special medical staff composed of respiratory department, ICU and department of infection control who were drawn from major hospitals. This management approach to acute respiratory infections was successfully implemented during severe acute respiratory syndrome(SARS) in 2003 in Qingdao.

The patient was transferred to the special ward of Chest Hospital on the hospital day 9 (February 12). From the 9th to the 12th day of hospitalization, the patient had no fever, cough was relieved, a small amount of white sputum, diarrhea was improved, and physical signs were normal. The test showed that the total bilirubin was higher, the lung texture of chest CT was clear, and there was no obvious sign of pneumonia. Abdominal CT showed no abnormal changes in liver and gallbladder. Under the basic principles of blood glucose monitoring, oxygen inhalation, continuous electrocardiographic monitoring, attention to rest and nutritional support, the patients were given iopinavir/ritonavir orally, a recombinant human interferon α 1b atomization inhalation therapy and traditional Chinese medicine. On the hospital day 12, due to the increase of bilirubin, iopinavir/ritonavir was stopped and ademetionine 1,4 - butanedisulfonate for injection was used.

On hospital day 13, the patient presented with itchy skin around the waist and umbilicus, mild cough, and no abdominal discomfort or diarrhea. The patient reported that he had skin eczema in the past, and the present symptoms were the same as those of the previous eczema.

There was no change in skin pruritus on the hospital day 14. Bilirubin was normal in the reexamination, and symatine (adenosine butylmethionine) was discontinued.

The nucleic acid was still positive in the review on hospital day 15, abidor orally was started.

On days 16 through 24 of hospitalization (days 20 through 28 of illness), the patient's all symptoms have resolved with the exception of the skin pruritus around the waist and umbilicus. The nucleic acid for 2019-nCov was still positive after reexamination on hospital day 17. On hospital day 19, the patient was given loratadine anti-allergy treatment.

On hospital day 20 the result of nucleic acid retest was still positive. The skin itchy on hospital day 21 was better. The nucleic acid test was sent again on hospital day 22(illness day 26), and the test report showed negative on day 23 of hospitalization, and it was submitted for test again, it was reported negative on hospital day 24. According to 2019-nCov pneumonia diagnosis and treatment plan of the office of Chinese Health and Health Commission and the office of the State Administration of Traditional Chinese Medicine, the results of two consecutive nucleic acid tests were negative more than one day apart. The patient was discharged on February 28 (hospital day 25, illness day 29).

The wife

The wife first developed fever of 39.4℃ on February 1, accompanied by chills, neither cough nor chest tightness, etc. On February 2, she was treated in a nearby hospital with oral drugs oseltamivir, levofloxacin, and traditional Chinese medicine, and her temperature dropped the next day. She went to the fever clinic of our hospital with her husband at 21:00 p.m. on February 4, and was admitted to the isolation ward of the fever clinic with her husband as a suspected case.

The wife had a history of hypertension for 20 years. Her blood pressure was well controlled by taking nifedipine controlled release tablets every day. She was a nonsmoker and had no other hobbies. The physical examination of admission revealed her temperature of 36.7℃, blood pressure of 147/103 mmHg, pulse of 92 beats per minute, respiratory rate of 20 beats per minute. She also received blood tests, CRP (Table 2), chest CT and nasopharynx nucleic acid tests, and no obvious pneumonia on chest CT (Fig. 2). Her 2019-nCov nucleic acid test report showed positive on February 5 (hospital day 2).

On February 6, the wife was febrile again with a maximum body temperature of 39.6℃. Ribavirin, oseltamivir, lopinavir/ritonavir, levofloxacin and traditional Chinese medicine were taken orally, and interferon a-2b atomization therapy was used; ibuprofen and arginine aspirin were given to reduce fever. She continued to take nifedipine controlled release tablets every day to control her blood pressure.

Febrile again on February 7, the body temperature of wife reached 39.9℃, the chest CT showed the progress of pulmonary lesions (see Table 2), the ECG showed frequent ventricular premature beats, and the blood electrolyte test showed that the low potassium was 2.9 mmol/l; paracetamol was given orally, indomethacin was used by anal medicine to reduce fever, thymosin alpha-1 for injection, recombinant human interferon a1b atomization inhalation, metoprolol orally and intravenous rehydration and potassium supplement, and Chinese medicine was given orally and intravenously.

On February 8, the patient's highest body temperature was 38.3°C, and the serum creatinine was detected to be 86.38 μmol/L. One acetaminophen tablet was given to reduce the fever, and intravenous medication of traditional Chinese medicine was continued.

On February 9, the maximum body temperature was 37.5°C, and on February 10, it dropped below 37°C; Then intravenous administration of traditional Chinese Medicine was stopped.

There was no fever on February 11, and the symptoms and signs were stable. Chest CT reexamination showed that the lung lesions were larger than before.

In February 12, the patient had occasional mild cough, no fever or other obvious discomfort after transferred to the chest hospital according to the arrangements of the Qingdao Municipal Health Commission about the confirmed patients treated centrally.

Her condition was stable on 13 and 14 February. On February 13, the test showed that total bilirubin and erythrocyte sedimentation rate (ESR) were significantly increased, C reactive protein (CRP) and high sensitivity C reactive protein (hsCRP) were increased, and serum fibrinogen was slightly higher (Table 2). Chest CT showed no significant change from February 11 (Fig. 2). Under the same basic principles as her husband, such as monitoring blood glucose, inhaling oxygen, continuous ecg monitoring, paying attention to rest and increasing nutrition, she continued to be given oral lopinavir/ritonavir and a recombinant human interferon α1b atomization inhalation therapy. Antihypertensive drug nifedipine controlled release tablets was given, and traditional Chinese medicine was continued.

After taking lopinavir/ritonavir on February 15, she felt obvious nausea, bitter mouth, no vomiting, and relieved by herself, no abdominal pain, no influence on appetite, no abnormal urine and feces, no fever, etc.

On February 16, the blood tests showed that the total bilirubin, ESR and CRP were all improved, and the chest CT reexamination showed that the lesions were absorbed compared with before. The reaction after taking lopinavir/ritonavir was the same as that of the previous day. The maximum postprandial blood sugar was 13.4 mmol/l, and no drug treatment was given.

On February 17 and 18, the symptoms were stable, and there was still nausea after taking lopinavir/ritonavir. The nucleic acid was still positive after review on February 18.

On the 19th, lopinavir/ritonavir was discontinued and abidol was initiated.

From February 21 to 24, the patient's all symptoms have resolved. The nucleic acid tests for 2019-nCov submitted on February 21 and 22 were all negative. On February 24 (hospital day 20, illness day 24), chest CT showed that the focus was obviously absorbed and improved. The blood tests showed that the total bilirubin and CRP was normal. Both alanine aminotransferase and aspartate aminotransferase were slightly higher. The wife discharged.

After discharge, the couple was quarantined for 14 days without any special discomfort. They were asked to return to the hospital in the first week, the next week and the fourth week for reexamination.

Discussion And Conclusions

Coronaviruses infection affects the respiratory and digestive tract of human or animal⁴. This couple accord with this kind of characteristic, but the disease performance of the same pathogen varied greatly after infecting different people at the same time. At the beginning of the disease after contacting with the same source of infection at the meantime, the husband and the wife had fever successively, and the subsequent symptoms were different. The main manifestation of the wife was respiratory system involvement, while the husband mainly presented with digestive tract symptoms, and finally they were all recovered. The diagnosis of the two patients met the Chinese criteria for suspected diagnosis of covid-19 at the time⁵, including epidemiological history, fever and chest CT findings or normal leukocyte count. They were admitted to the hospital and quarantined, and subsequently confirmed by covid-19 nucleic acid test.

The wife showed unusually high fever, with a maximum body temperature of 39.9°C. High fever not only appeared repeatedly, but was not easy to control and needed multiple medications, and accompanied with that her chest CT showed the pulmonary shadows were gradually aggravated. After body temperature dropped, chest CT also stopped progressing and gradually improved. The degree of fever was consistent with the development of pulmonary lesions. The other indicators concurrent with the progress of the disease were the increases of both CRP and ESR. The wife showed elevated bilirubin, which also occurred after taking lopinavir/ritonavir, and it has been reported that the administration of lopinavir/ritonavir is related to liver function damage⁶, at the same time, the patient had obvious nausea and discomfort after taking lopinavir/ritonavir which gradually disappeared after the drug was discontinued, so the elevated bilirubin was likely to be associated with both lopinavir/ritonavir medication and viral infection which have been reported¹⁸.

The husband had high fever for one day before hospitalization, and the maximum temperature was 37.5 °C after admission. Although the cough was severe, his chest CT showed only a small and light shadow, which disappeared quickly. The disease was confined to the tracheobronchial area and not developed in the lung. The biggest discomfort in the husband's complaint was diarrhea, 2–4 times a day. Blood tests showed increases in blood CRP and ESR, both of which were less severe than in his wife. The reason for the increase of bilirubin in husband also needs to consider the two factors of drug and virus infection. The husband's overall condition was milder than his wife's, with no major ups and downs or dramatic fluctuations, but the nucleic acid test took longer to be positive than his wife's. In this sense, the patient with mild symptoms was not necessarily shorter than the patient with severe symptoms in terms of the length of time that the disease was infectious.

Both the husband and the wife showed slight elevation of transaminase, which occurred at the stage of improvement, especially after the wife's negative result of nucleic acid test. Therefore, they were likely to have nothing to do with viral infection and related to the use of antiviral drugs. Neither of the couple had significant leucopenia or reduced lymphocyte count.

Symptoms of covid-19 have been widely reported, and some are associated with progress of the disease, such as dyspnea, which may indicate the deterioration of the disease⁷. Clinical examination such as chest CT progression is a direct indicator of deterioration⁸. In our case, it was found that some simple tests, such as the increase or decrease of ESR or CRP, are consistent with the progress or improvement of novel coronavirus infection, as well as with the degree and duration of fever. They are good indicators to reflect the severity and development of the disease. Moreover, the detection method is simple and low-cost, which is very practical in clinical use.

Because of the detection of covid-19 virus in blood and feces, as well as the possible infectivity of patients^{9,10}, and in the February of the patient's illness, the nucleic acid test of stool and serum and the test of coronavirus antibody could not be completed due to the limited conditions. According to the instructions of the national diagnosis and treatment plan for covid-19¹¹, the expert group for covid-19 infection in Qingdao adopted the strategy of recommending patients to continue to be isolated for 14 days after discharge, and gave patients timely follow-up.

Neither patient developed significant respiratory failure and the condition remained mild to moderate in this case. During the course of the disease, both the husband and the wife had obvious hypokalemia, and the wife had a brief premature heart beat. Hypokalemia is easy to induce arrhythmia and heart failure¹²⁻¹⁶, even related to some malignant arrhythmias¹⁷, especially for patients with basic heart disease. Fortunately, the hypokalemia that developed in this couple was easy to correct and not stubborn. So hypokalemia should be pay attention to prevent when the urine volume is sufficient if there is fever or diarrhea in patients who infected with the covid-19. Supportive therapy had ever played an important role in the treatment of Ebola virus infection, including oral or intravenous electrolyte replacement fluids to correct metabolic abnormalities¹⁹, which may still need attention in the infection of COVID-19.

Declarations

Acknowledgements

Not applicable .

Availability of data and materials

All the data supporting the conclusions of this article are included in the present article.

Authors' contributions

YZ performed literature search, manuscript design, writing, and patients follow-up. SML conducted article design and literature retrieval, collected medical history and instructed case writing and patients follow-up. HPT guided case analysis and article writing. RZ collected case data; JL collected part of patients data; JYC and FW participated in case analysis. FZ was responsible for the collection of patients' laboratory nucleic acid data. JYL and SJL were responsible for observing the condition of the patients. FHL was involved in the acquisition of patients laboratory data. All authors approved the final manuscript.

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Ethics approval and consent to participate

Ethical approval is not required because this is a single case report that involves only a retrospective review of medical records and does not include data that can identify the patient. Written informed consent was obtained from the patient for participation in this case report.

Consent for publication

Written informed consent for publication of the clinical details and clinical images was obtained from the patient.

Competing interests

The authors declare that they have no competing interests.

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References

1. Gorbalenya, A.E., Baker, S.C., Baric, R.S., de Groot, R.J., Drosten, C., Gulyaeva, A.A., et al., 2020. Severe Acute Respiratory Syndrome-Related Coronavirus: The Species and Its Viruses – A Statement of the Coronavirus Study Group. bioRxiv <https://doi.org/10.1101/2020.02.07.937862> 2020.02.07.937862.
2. WHO, 2020a. Clinical Management of Severe Acute Respiratory Infection when Novel Coronavirus (nCoV) Infection Is Suspected: Interim Guidance. World Health Organization (WHO).
3. Rajesh T. Gandhi, John B. Lynch, M.P.H., Carlos del Rio. Mild or Moderate Covid-19. N Engl J Med. 2020 Apr 24. doi: 10.1056

4. [Jie Cui, Fang Li , Zheng-Li Shi](#). Origin and Evolution of Pathogenic Coronaviruses. *Nat Rev Microbiol*. 2019 Mar;17(3):181-192.doi: 10.1038/s41579-018-0118-9.
5. General Office of the National Health Commission of the People's Republic of China—Office of the National Administration of Traditional Chinese Medicine. Diagnosis and Treatment of Novel Coronavirus Pneumonia (trial version fourth). 2020 Jan 27.
6. [Zhenyu Fan, Liping Chen, Jun Li , Xin Cheng , Jingmao Yang , Cheng Tian , Yajun Zhang , Shaoping Huang , Zhanju Liu , Jilin Cheng](#). Clinical Features of COVID-19-Related Liver Damage. *Clin Gastroenterol Hepatol*. 2020 Apr 10;S1542-3565(20)30482-1.doi: 10.1016/j.cgh.2020.04.002.
7. [Dawei Wang, Bo Hu, Chang Hu, Fangfang Zhu, Xing Liu, Jing Zhang, Binbin Wang, Hui Xiang, Zhenshun Cheng, Yong Xiong, Yan Zhao, Yirong Li, Xinghuan Wang, Zhiyong Peng](#). Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA*.2020 Feb 7;323(11):1061-1069. doi: 10.1001
8. [Tao Ai, Zhenlu Yang, Hongyan Hou, Chenao Zhan, Chong Chen, Wenzhi Lv, Qian Tao, Ziyong Sun, Liming Xia](#). Correlation of Chest CT and RT-PCR Testing in Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. *Radiology*. 2020 Feb 26;200642.doi: 10.1148
9. [Wei Zhang, Rong-Hui Du, Bei Li, Xiao-Shuang Zheng, Xing-Lou Yang, Ben Hu, Yan-Yi Wang , Geng-Fu Xiao, Bing Yan , Zheng-Li Shi , Peng Zhou](#). Molecular and Serological Investigation of 2019-nCoV Infected Patients: Implication of Multiple Shedding Routes. *Emerg Microbes Infect*. 2020 Feb 17;9(1):386-389.doi: 10.1080/22221751.2020.1729071.eCollection 2020.
10. [Natalie M Linton, Tetsuro Kobayashi, Yichi Yang, Katsuma Hayashi, Andrei R Akhmetzhanov, Sung-Mok Jung, Baoyin Yuan, Ryo Kinoshita, Hiroshi Nishiura](#). Incubation Period and Other Epidemiological Characteristics of 2019 Novel Coronavirus Infections With Right Truncation: A Statistical Analysis of Publicly Available Case Data.*J Clin Med*. 2020 Feb 17;9(2):538.doi: 10.3390/jcm9020538.
11. General Office of the National Health Commission of the People's Republic of China—Office of the National Administration of Traditional Chinese Medicine. Diagnosis and Treatment of Novel Coronavirus Pneumonia (trial version sixth). 2020 Feb 19.
12. [Jonas Skogestad, Jan Magnus Aronsen](#). Hypokalemia-Induced Arrhythmias and Heart Failure: New Insights and Implications for Therapy. *Front Physiol*. 2018 Nov 7;9:1500.doi: 10.3389/fphys.2018.01500. eCollection 2018.
13. [Allan J Collins , Bertram Pitt, Nancy Reaven, Susan Funk, Karen McGaughey, Daniel Wilson, David A Bushinsky](#). Association of Serum Potassium With All-Cause Mortality in Patients With and Without Heart Failure, Chronic Kidney Disease, and/or Diabetes.*Am J Nephrol*.2017;46(3):213-221.doi: 10.1159/000479802.
14. [Kiarash Tazmini, Michael Frisk , Alexandre Lewalle, Martin Laasmaa, Stefano Morotti, David B Lipsett, Ornella Manfra , Jonas Skogested, Jan M Aronsen, Ole M Sejersted, Ivar Sjaastad, Andrew G Edwards, Eleonora Grandi , Steven A Niederer , Erik Øie, William E Louch](#). Hypokalemia Promotes

Arrhythmia by Distinct Mechanisms in Atrial and Ventricular Myocytes. *Circ Res*. 2020 Mar 27;126(7):889-906. doi: 10.1161/CIRCRESAHA.119.315641.

15. [C Barrett Bowling](#), [Bertram Pitt](#), [Mustafa I Ahmed](#), [Inmaculada B Aban](#), [Paul W Sanders](#), [Marjan Mujib](#), [Ruth C Campbell](#), [Thomas E Love](#), [Wilbert S Aronow](#), [Richard M Allman](#), [George L Bakris](#), [Ali Ahmed](#). Hypokalemia and Outcomes in Patients With Chronic Heart Failure and Chronic Kidney Disease: Findings From Propensity-Matched Studies. *Circ Heart Fail*. 2010 Mar;3(2):253-60. doi: 10.1161/CIRCHEARTFAILURE.109.899526. Epub 2010 Jan 26.
16. James N. Weiss, Zhilin Qu, Kalyanam Shivkumar. The Electrophysiology of Hypo- and Hyperkalemia. *Circ Arrhythm Electrophysiol*. 2017 March ; 10(3): . doi:10.1161/CIRCEP.116.004667.
17. [Gaetano M De Ferrari](#), [Veronica Dusi](#), [Marta Ruffinazzi](#), [Lucrezia C Masiello](#), [Enrico Ruffino](#), [Luisa Cacciavillani](#), [Patrizia Noussan](#), [Valerio Zacà](#), [Tommaso Sanna](#) , [Marina L Lazzarotti](#), [Tullio Usmiani](#), [Massimiliano Gnechi](#), [Gianfranco Parati](#) , [Lia Crotti](#) , [Peter J Schwartz](#) , [ESCAPE-NET Investigators](#). Risk Factors for Primary Ventricular Fibrillation During a First Myocardial Infarction: Clinical Findings From PREDESTINATION (PRimary vEntricular Fibrillation and suDden dEath During firST myocardial iNfArcTION). *Int J Cardiol*. 2020 Mar 1;302:164-170. doi: 10.1016/j.ijcard.2019.10.060. Epub 2019 Nov 19.
18. [I-Cheng Lee](#), [Teh-la Huo](#), [Yi-Hsiang Huang](#). Gastrointestinal and Liver Manifestations in Patients With COVID-19. *J Chin Med Assoc*. 2020 Apr 1;10.1097/JCMA.0000000000000319. doi: 10.1097/JCMA.0000000000000319.
19. [Timothy M Uyeki](#), [Aneesh K Mehta](#), [Richard T Davey Jr](#), [Allison M Liddell](#), [Timo Wolf](#), [Pauline Vetter](#), [Stefan Schmiedel](#), [Thomas Grunewald](#), [Michael Jacobs](#), [Jose R Arribas](#), [Laura Evans](#), [Angela L Hewlett](#), [Arne B Brantsaeter](#), [Giuseppe Ippolito](#), [Christophe Rapp](#), [Andy I M Hoepelman](#), [Julie Gutman](#), [Working Group of the U.S.–European Clinical Network on Clinical Management of Ebola Virus Disease Patients in the U.S. and Europe](#). Clinical Management of Ebola Virus Disease in the United States and Europe. *N Engl J Med*. 2016 Feb 18;374(7):636-46. doi: 10.1056/NEJMoa1504874.

Tables

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Figures

Figure 1
(caption included in image)

Figure 2

(caption included in image)

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