

SARS-CoV-2 Infections among Recent Organ Recipients, March–May 2020, United States

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We conducted public health investigations of 8 organ transplant recipients who tested positive for severe acute respiratory syndrome coronavirus 2 infection. Findings suggest the most likely source of transmission was community or healthcare exposure, not the organ donor. Transplant centers should educate transplant candidates and recipients about infection prevention recommendations.

Although severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection has been reported in organ transplant recipients, it is unclear whether SARS-CoV-2 can be transmitted from organ donors to recipients (1) and if transplant recipients are at increased risk for severe illness from coronavirus disease (COVID-19) from SARS-CoV-2 infection compared with immunocompetent patients (2). In March 2020, organ procurement organizations

(OPOs) and transplant centers in the United States began to report potential donor-derived SARS-CoV-2 transmission to the Organ Procurement and Transplantation Network (OPTN) for investigation by the Disease Transmission Advisory Committee (DTAC). These cases were referred to the Centers for Disease Control and Prevention (CDC), a member of DTAC, to determine if SARS-CoV-2 transmission from a donor had occurred and, if so, to identify the transmission source, and characterize clinical outcomes in the organ recipients.

The Study

Current OPTN policy requires all US transplant centers and OPOs to report unanticipated potential donor-derived transmission events to the OPTN for investigation by DTAC. CDC coordinates investigations involving pathogens of special interest, including SARS-CoV-2 (Appendix, <https://wwwnc.cdc.gov/EID/27/2/20-4046-App1.pdf>).

For all reported potential donor-derived SARS-CoV-2 transmissions, CDC, OPO, or the transplant center staff reviewed medical records of organ donors and organ recipients. Recipients who initially tested positive for SARS-CoV-2 infection and triggered a notification to the OPTN of a potential donor-derived transmission were referred to as index recipients; recipients who shared a common donor with index recipients were referred to as co-recipients. CDC investigators asked OPO and index recipients' hospital staff about potential exposures to SARS-CoV-2. Transplant hospital providers monitored organ recipients for symptoms of COVID-19 for ≥ 14 days following the transplant. Recipients who developed symptoms and, depending on hospital capacity, some asymptomatic recipients were tested for SARS-CoV-2 infec-

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DOI: <https://doi.org/10.3201/eid2702.204046>

tion by a nucleic acid test (NAT). All donor serum were tested for the presence of SARS-CoV-2 RNA. Donor respiratory specimens were tested if available.

During March–May 2020, a total of 8 potential donor-derived transmission events involving 8 deceased donors and 31 recipients were reported to OPTN. Each event was reported because an individual transplant recipient (the index recipient) tested positive for SARS-CoV-2 infection (Table 1; Appendix). For all donors included in this study, the cause of death was determined to be a noninfectious etiology. Donor next of kin reported that no donors had had symptoms of COVID-19 or contact with persons known to have COVID-19. One donor was screened for SARS-CoV-2 infection by the OPO using a NAT before organ procurement and tested negative.

Among the 8 index recipients, 4 received lung, 2 received liver, and 2 received heart transplants (Table 2, <https://wwwnc.cdc.gov/EID/article/27/2/20-4046-T2.htm>). The median age of index recipients was 65 years (range 37–75 years); the median duration from organ transplantation to symptom onset was 9 days (range 6–81 days). Seven (88%) index

recipients experienced fever or lower respiratory tract symptoms. Seven index recipients required mechanical ventilation; 3 of them (2 liver recipients and 1 lung recipient) died. All index recipients had potential or confirmed community or healthcare exposure to persons infected with SARS-CoV-2.

Organs from the 8 deceased donors were transplanted into 31 recipients, including the 8 index recipients. Of the 23 co-recipients, 11 (48%) were tested for SARS-CoV-2 infection using a NAT; 1 tested positive 41 days after transplant. Twelve co-recipients were not tested because of absence of symptoms and need to conserve test supplies. Within 14 days after transplant, 3 co-recipients manifested symptoms related to COVID-19, but all tested negative.

Conclusions

The 8 potential donor-derived SARS-CoV-2 transmissions reported to the OPTN during March–May 2020 were referred to CDC for public health investigation. Although the source of transmission was not definitively established, the available evidence did not suggest transmission occurred from donors.

Table 1. Epidemiologic and clinical characteristics of solid organ donors associated with potential SARS-CoV-2 transmission investigations, United States, March–May 2020*

Donor	Cause of death	Organs procured from donor and transplanted into other recipients	Chest radiograph and chest CT findings	Donor lung disposition	Results of BAL PCR	Results of serum PCR	Results of nasopharyngeal PCR
A	Hemorrhagic stroke	Bilateral lungs, liver, left kidney	Bilateral lower lobe consolidations	Both lungs transplanted	Negative	Negative	NT
B	Ischemic stroke	Right lung, liver, left kidney	Bilateral lower lobe consolidations	Single lung not allocated in time	NT	Negative	NT
C	Opioid overdose	Bilateral lungs, liver, left kidney, right kidney, pancreas	Bilateral lower lobe consolidations	Both lungs transplanted	NT	Negative	NT
D	Head trauma	Liver, left kidney, right kidney, heart	Bilateral lower lobe consolidations	Lungs not transplanted because of traumatic damage	NT	Negative	NT
E	Hemorrhagic stroke	Bilateral lungs, right kidney, left kidney/split liver, split liver, heart	No focal infiltrates, small pneumomediastinum	Both lungs transplanted	NT	Negative	NT
F	Head trauma	Left lung, right lung, liver, and heart	Bilateral lower lobe consolidations	Both lungs transplanted	NT	Negative	NT
G	Head trauma	Heart/left kidney, liver, right kidney/pancreas	Bilateral lower lobe consolidations	Lungs not transplanted because of abnormal chest imaging	NT	Negative	NT
H	Opioid overdose	Heart, left kidney, right kidney, liver	Patchy ground glass in all lobes	Lungs not transplanted because of abnormal chest imaging	NT	Negative	Negative

*In the 14 days before death, none of the donors had known contact with someone who had been sick with or received a diagnosis of coronavirus disease, had traveled, or had reported nosocomial transmission of SARS-CoV-2 in the donor hospital. None of the donors experienced symptoms consistent with COVID-19, including fever, cough, and shortness of breath. BAL, bronchoalveolar lavage; CT, computed tomography; COVID-19: coronavirus disease; NT, not tested; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

The risk for organ donor-derived SARS-CoV-2 transmission is unknown (1,3). Transmission of severe acute respiratory syndrome coronavirus, Middle East respiratory syndrome coronavirus, or SARS-CoV-2 from an organ or blood donor to a recipient has not been reported as of November 2020 (1). However, recent studies documented the presence of viral particles in organs of patients who had severe COVID-19 or died from COVID-19 (4–6). Infectious SARS-CoV-2 has been isolated from respiratory specimens, stool (7), and urine (8), suggesting transmissible virus might be present in extrapulmonary organs. Although these studies suggest that transplant transmission is plausible, the risk for SARS-CoV-2 transmission from extrapulmonary organs of asymptomatic infected deceased donors to organ recipients is unknown. Evidence suggests that the risk for viremia in persons with asymptomatic COVID-19 is low (9). However, OPOs should continue to evaluate donors for evidence of SARS-CoV-2 infection (10) because transmission of SARS-CoV-2 from organ donor to recipient might be possible and subsequent recipient infection might be severe; evaluating donors could also protect organ procurement and transplantation clinical teams. The American Society of Transplantation has recommended testing all donors by NAT since May 2020. No donors in this study had reported contact with persons with confirmed or suspected COVID-19.

COVID-19 has an estimated incubation period of 2–14 days (10), and all index recipients had confirmed or potential SARS-CoV-2 exposure during the 14 days before symptom onset or diagnosis. No co-recipients contracted COVID-19 within 14 days of transplant, providing further support that the donor was not the source of transmission. Transplant recipients and their healthcare providers should continue to take steps to reduce SARS-CoV-2 exposure.

Of the 8 index recipients in this study, 7 were intubated and 3 died. Seven of the index recipients received their COVID-19 diagnosis within 14 days of transplantation, which suggests that recipients of recent transplants may be at increased risk for severe disease compared with the general population (11) and possibly with organ recipients whose transplants were done months or years before SARS-CoV-2 infection (12). The advanced age of the index recipients in our study might have contributed to increased illness. Although some COVID-19 case series have suggested that organ transplant recipients are at higher risk for severe disease than the general population, others suggest that disease severity is similar (2,11). Data are sparse on the clinical severity of COVID-19 in recently transplanted organ recipients.

This study is subject to the following limitations. First, 7 of 8 donors were not tested for SARS-CoV-2 before transplant, and stored respiratory specimens were unavailable for retrospective testing. Although donor serum specimens were tested by NAT, limited performance and sensitivity data are available for this sample type using this test, and SARS-CoV-2 viremia is likely uncommon and intermittent (1). Second, donors and recipients might have had contact with unidentified persons with SARS-CoV-2 infection, including asymptomatic or presymptomatic persons (13). Asymptomatic SARS-CoV-2 infection might not have been detected in co-recipients given the low rate of testing (<50%). Finally, donor-derived SARS-CoV-2 transmission might not have been recognized by transplant clinicians and therefore not reported for investigation.

COVID-19 in the organ transplant recipients we report appears to have been community- or hospital-acquired. These findings suggest that organ transplant recipients, particularly in the immediate posttransplant period, might be at increased risk for severe COVID-19. Measures to limit household and healthcare-associated SARS-CoV-2 transmission to recipients should be implemented (10,14,15). All suspected donor-derived SARS-CoV-2 infections should be reported to the OPTN for further investigation.

Acknowledgments

We thank members of the Disease Transmission Advisory Committee and staff from the United Network of Organ Sharing staff, organ procurement organizations, and transplant centers for their assistance with the investigations.

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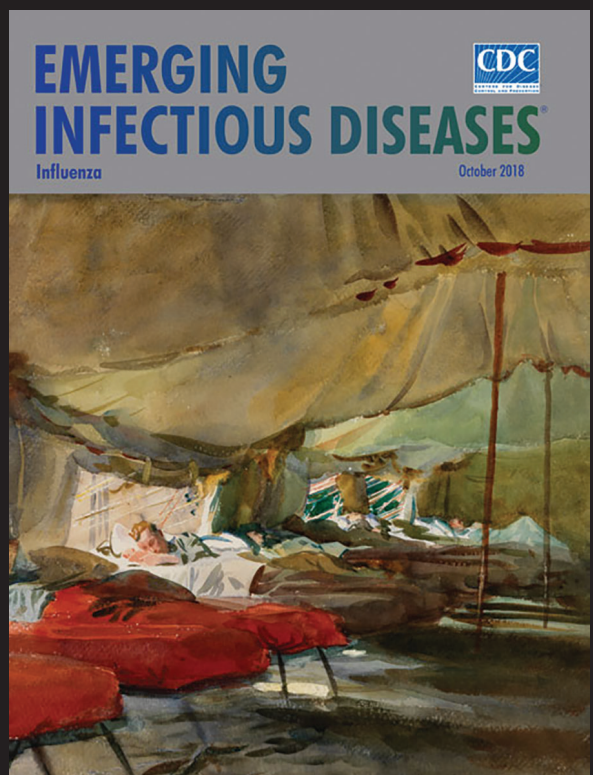
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Appendix

Index Recipient Investigation

Methods

All organ procurement organizations (OPOs) and transplant centers in the United States are members of the Organ Procurement and Transplantation Network (OPTN). Current OPTN policy requires transplant centers and OPOs to report unanticipated potential donor-derived transmission events to the OPTN for investigation by DTAC. CDC coordinates investigations involving pathogens of special interest, including severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

For all reported potential donor-derived SARS-CoV-2 transmissions, CDC, OPO, or transplant center staff reviewed medical records of donors and recipients, including SARS-CoV-2 testing and chest imaging reports. The donor clinical history was reviewed to look for evidence of symptoms consistent with COVID-19, including fever, cough, or shortness of breath. OPO staff asked donor next of kin if the donor had been exposed to someone who had been diagnosed with COVID-19. Additional information included whether the donor had contact with any sick persons or any travel in the 2 weeks prior to death. Recipients who initially tested positive for SARS-CoV-2 infection and triggered a notification to the OPTN of a potential donor-derived transmission were referred to as index recipients, and recipients who shared a common donor with index recipients are referred to as co-recipients. CDC investigators asked OPO and index recipient hospital staff if nosocomial transmission of SARS-CoV-2 had occurred in donor or recipient hospitals. CDC investigators collected information from transplant centers and OPOs about potential exposure to SARS-CoV-2 for index recipients during the 14 days before symptom onset, including contact with persons with fever or respiratory symptoms or a diagnosis

of COVID-19, travel, and hospitalization prior to admission for the transplant procedure. Confirmed exposure was defined as reported contact (e.g., living with a person or being treated by a healthcare worker) with a person diagnosed with COVID-19 during the infectious period (1). Potential healthcare exposure was defined as treatment in a healthcare facility with known or suspected nosocomial transmission without a confirmed contact. Potential community exposure was defined as contact with a person meeting a probable COVID-19 case definition (2).

Transplant hospital providers monitored organ recipients for symptoms of COVID-19 (fever, cough, shortness of breath, fatigue, myalgias, sore throat, headache, congestion, and other concerning symptoms) for ≥ 14 days following the transplant. Some asymptomatic recipients, depending on hospital capacity, and recipients who developed symptoms were tested for SARS-CoV-2 infection using a nucleic acid test (NAT) on a nasopharyngeal specimen.

Because donor respiratory specimens (e.g., sputum, bronchioalveolar lavage, nasopharyngeal swab) were only available for 1 donor, donor serum (which is archived per routine OPO practice) was tested for the presence of SARS-CoV-2 RNA by processing with the EZ1 nucleic acid extractor with the EZ1 DSP Virus Kit (QIAGEN, <https://www.qiagen.com>) followed by real-time RT-PCR as previously described (3,4).

Results

Donor Clinical and Epidemiologic Findings

For all donors included in this study, the cause of death was determined to be a noninfectious etiology, including stroke, opioid overdose, and head trauma. Next of kin of the 8 organ donors reported that none of the donors had symptoms of COVID-19 or contact with persons known to have COVID-19. Donor chest imaging reports documented infiltrates in 7 (88%) donors. For 4 of those 7 (57%) donors, OPO or the lung transplant center medical staff determined the chest imaging results to be unremarkable, and the lungs were transplanted. Lungs from 1 donor had evidence of trauma and were not transplanted. Due to abnormal chest imaging, lungs from 2 donors were not transplanted. One donor was screened for SARS-CoV-2 infection using a NAT on a respiratory specimen by the OPO prior to organ procurement and tested negative; the test was conducted using an in-house assay authorized by the US Food and Drug Administration under an Emergency Use Authorization. None of the 8 donor serum specimens had detectable SARS-CoV-2 RNA. No donors were tested for SARS-CoV-2 antibodies.

Index Recipients

Of the 8 index recipients, 4 received lung, 2 received liver, and 2 received heart transplants (Table 2). Seven (88%) index recipients were male, and the median age of index recipients was 65 years (range 37–75 years); the median duration from organ transplantation to symptom onset was 9 days (range 6–81 days). Seven (88%) index recipients developed fever or lower respiratory tract symptoms. Seven index recipients required mechanical ventilation; 3 of those, 2 liver recipients and 1 lung recipient, died. Seven index recipients were given induction immunosuppressive therapy that included basiliximab, an interleukin-2 antagonist. All index recipients received investigational therapy for COVID-19. Treatment regimens included hydroxychloroquine, azithromycin, remdesivir, convalescent plasma, intravenous immunoglobulin, or tocilizumab. All index recipients had potential or confirmed community or healthcare exposure to persons infected with SARS-CoV-2. Four (50%) index recipients had close contact with a healthcare worker with laboratory-confirmed SARS-CoV-2 infection during the 14 days prior to symptom onset. Two index recipients were hospitalized in facilities with potential nosocomial transmission. Two index recipients had contact with household members with laboratory-confirmed COVID-19. Only 1 index recipient had a pretransplant specimen available for testing, and it tested negative by NAT for SARS-CoV-2. Detailed clinical reports of index recipients A and G have been published (5,6).

Co-recipients

From the 8 deceased donors, organs were transplanted into 31 recipients, including the 8 index recipients (Appendix Table). Among the 23 co-recipients, 11 (48%) were tested for evidence of SARS-CoV-2 infection; all tests used a NAT on a nasopharyngeal swab or bronchoalveolar lavage specimen. Ten of these 11 co-recipients tested negative. One asymptomatic co-recipient was tested 41 days after transplant when she was admitted for a routine follow-up procedure and tested positive. None were tested for SARS-CoV-2 antibodies. Within 14 days after transplant, 1 co-recipient experienced fever, 1 required additional oxygen, and 1 had diarrhea. All 3 of these recipients tested negative for SARS-CoV-2 infection. Three co-recipients experienced symptoms, including vomiting, diarrhea, shortness of breath, or rhinorrhea, \leq 14 days after transplant, but all tested negative for SARS-CoV-2 infection. SARS-CoV-2 testing was not performed on the other 12 co-recipients because these patients did not

have COVID-19 symptoms, and the transplant centers prioritized testing capacity for symptomatic patients. No co-recipients were tested for SARS-CoV-2 antibodies.

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Appendix Table. COVID-19 symptoms and SARS-CoV-2 test results of non-index solid organ recipients (co-recipients) associated with potential SARS-CoV-2 transmission investigations, United States, March–May 2020

Donor	Organ received	Symptoms of COVID-19 (days posttransplant at which symptoms started)	SARS-CoV-2 PCR results (days posttransplant at which tests performed)
A	Liver	None	Not tested
	Left kidney	None	Not tested
B	Liver	None	Negative nasopharyngeal swab (18)
	Left kidney	None	Negative nasopharyngeal swab (18)
C	Bilateral lungs	None	Negative bronchoalveolar lavage specimen (17)
	Left kidney	None	Negative nasopharyngeal swab (17)
	Right kidney	Fever (14)	Negative nasopharyngeal swab (18)
	Pancreas	Rhinorrhea (26)	Negative nasopharyngeal swab (26)
D	Left kidney	None	Not tested
	Right kidney	None	Not tested
	Heart	None	Positive nasopharyngeal swab (41)
E	Right kidney	None	Not tested
	Left kidney/split liver	None	Not tested
	Split liver	None	Not tested
	Heart	None	Not tested
F	Right lung	Hypoxia (8)	Negative nasopharyngeal swab (8, 9, 12)
	Liver	Diarrhea and vomiting (15)	Negative nasopharyngeal swab (18, 20)
	Heart	Diarrhea (10)	Negative nasopharyngeal swab (7, 10)
G	Liver	None	Not tested
	Right kidney/pancreas	None	Not tested
H	Left kidney	None	Not tested
	Right kidney	None	Not tested
	Liver	None	Negative nasopharyngeal swab (19, 26)