Acknowledgments

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Dr. Herbst is a research associate and Dr. Duque Velásquez is a postdoctoral fellow at the University of Alberta. Their primary research interest is the mechanism(s) of pathogenicity underlying neurodegeneration, as exemplified by prion diseases in animals and humans.

References


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We report rabies virus transmission among solid organ transplantation recipients in Changsha, China, in 2016. Two recipients were confirmed to have rabies and died. Our findings suggest that more attention should be paid to the possibility of rabies virus transmission through organ transplantation for clinical and public health reasons.

In 2016, Zhou et al. reported a case of rabies virus transmission in China that was probably a result of organ transplantation (1). We report on rabies transmission that occurred among solid organ transplant recipients in Changsha, China, during December 2015–January 2016.

In November 2015, the donor, a previously healthy boy, showed development of fever, insomnia, and agitation. On day 6 of infection, these symptoms progressed, and he was sent to a healthcare center. At this time, he experienced weakness, no desire to drink water, poor appetite, and panic. One day later, he began vomiting, and was admitted to a local hospital (hospital A), where he exhibited anemophilia, convulsions, limb rigidity, and hypersalivation. The patient was moved to hospital B (days 7–14) in Changsha. At admission, some examination findings indicated a possibility of viral encephalitis (online Technical Appendix, Table 1, https://wwwnc.cdc.gov/EID/article/23/9/16-1704-eid2005.130778). Subhypothermia hibernation therapy and assisted ventilation were administered within 72 hours of admission, and the patient’s vital signs became stable. On day 10, hypotenremia was observed, and on day 11, the patient again became febrile and tachycardic, with hypertension, no desire to drink water, poor appetite, and panic. One day later, he began vomiting, and was admitted to a local hospital (hospital A), where he exhibited anemophilia, convulsions, limb rigidity, and hypersalivation. Subhypothermia hibernation therapy and assisted ventilation were administered within 72 hours of admission, and the patient’s vital signs became stable. On day 10, hypotenremia was observed, and on day 11, the patient again became febrile and tachycardic, with hypertension, no desire to drink water, poor appetite, and panic.

On day 14, the patient was transferred to hospital C, where he became comatose and was declared brain dead. Permission was granted for organ donation, because no specific pathogen had been detected and China’s organ

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transplant policy allows for organ donations in cases of viral encephalitides without laboratory-confirmed pathogens. Rabies virus–specific binding antibodies were also not detected in the serum samples. The donor had possibly been exposed to rabies but had not been vaccinated against rabies (online Technical Appendix). The patient’s kidneys and liver were removed for transplantation in hospital D in Changsha on the following day.

Kidney and liver transplantations were performed on December 10, 2015. Two female recipients in hospital D received the kidneys, and an 8-month-old girl in hospital E in Shanghai, China, received the liver. No other organs were collected or transplanted from this donor. The surgeries were all uneventful, and the recipients were discharged after transplantation. However, all 3 recipients were eventually readmitted to the hospital with complex symptoms (Figure).

On the 40th day after transplantation, the left kidney recipient (29 years of age) revisited hospital D, reporting worsening right quadrant abdominal pain and vomiting. In the next 3 days, she successively had anemophobia, shortness of breath, chest tightness, anxiety, insomnia, and hypersalivation. During hospitalization, her blood pressure was as high as 248/148 mm Hg. On her 7th day in the hospital, she became comatose and then died.

On the 43rd day after transplantation, the right kidney recipient (age 47 years) developed aches in her lower limbs, insomnia, and a decreased appetite. She was readmitted to hospital D the next day. On the 3rd day after admission, she exhibited hydrophobia, anemophobia, photosthesia, and fatigue. She showed agitation, dyspnea, and hypersalivation on the 4th day; she became comatose and died 1 day later.

The liver recipient was readmitted with pneumonia on the 34th day after transplantation and died of asphyxia and

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**Figure.** Clinical course of a donor and 3 recipients in a rabies outbreak associated with solid organ transplantation, Changsha, China, 2015–2016.
multiple organ failure within 5 days. This patient did not show any signs or symptoms of rabies or encephalitis.

None of the recipients had been exposed to potentially rabid animals or had been vaccinated previously for rabies (online Technical Appendix). Both kidney recipients tested positive for rabies virus (online Technical Appendix Table 2). The genome sequences of the rabies virus isolates from the right kidney recipient (isolate no. CCS1501H) were \( \approx 11 \) kb nucleotides in length and belonged to the China I lineage. No testing for rabies was done on the donor or on the liver recipient.

In the past 10 years, rabies transmission by solid organ transplantation has been described occasionally worldwide (2–4). Hence, rabies transmission through organ transplantation is a clinical and public health concern. To prevent future cases such as this, we recommend that patients with unexplained encephalitis or mental status changes should not be used as organ donors even if tests for some infectious causes of encephalitis are negative. In addition, if rabies is suspected in the donor after organs have been transplanted, the recipients should also not be used as organ donors. An antibody test is not the ideal choice for the diagnosis of rabies virus and by itself cannot reliably exclude rabies from the differential diagnosis. For this reason, a combination of multiple techniques, preferably direct fluorescent antibody test and reverse transcription PCR, should be used before organ transplantation, especially when the donor is suspected of having rabies or a potential exposure to rabies. In addition, if a patient has meningoencephalitis of unknown cause, a specific epidemiologic and laboratory evaluation should be performed to conclusively rule out rabies as a cause of illness before organ donation.

Dr. Shuilian Chen is a medical doctor in the Changsha Center for Disease Control and Prevention in Changsha, China. Her main field of research is emerging infectious disease control and prevention.

References

Identification of Clade E Avipoxvirus, Mozambique, 2016

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Analysis of scab samples collected from poultry during outbreaks of fowlpox in Mozambique in 2016 revealed the presence of clade E avipoxviruses. Infected poultry were from flocks that had been vaccinated against fowlpox virus. These findings require urgent reevaluation of the vaccine formula and control strategies in this country.

Avipoxviruses are large, enveloped DNA viruses that belong to the genus Avipoxvirus in the Chordopoxvirinae subfamily of the family Poxviridae. These viruses cause disease in a large number of bird species and are generally named after the species from which the virus was first isolated and characterized (1). Fowlpox virus (FPV) has caused substantial economic losses in domestic poultry resulting from reduced egg production and growth, blindness, and death, with a death ratio that can reach as high as 50%.

Phylogenetic analyses of the Avipoxvirus genus are usually conducted with the segments of the genes encoding the 4b core-like protein (P4b) and the DNA polymerase, which are both highly conserved among poxviruses (2,3). Using these loci, researchers have seen that most strains cluster into 3 major clades, namely A, B, and C, with clade A being subdivided further into subclades A1–A7 and clade B into subclades B1–B3 (3–5). Two additional clades

Technical Appendix

Epidemiologic Information on Donor and the 2 Kidney Transplant Recipients in a Rabies Outbreak Associated with Solid Organ Transplantation, Changsha, China, 2015–2016

Family members reported that the donor had been hurt outside the house 2 months previously, with 1 wound each on the forehead and occiput. The reasons for the injuries were unclear, and he had not been vaccinated for rabies. Our field investigation showed that many stray dogs lived in the donor’s village; thus, the donor may have been bitten by a stray dog(s). Interviews with the kidney transplant recipients and their family members indicated that the recipients had neither been exposed to potentially rabid animals nor been vaccinated previously for rabies. Therefore, transplantation was a possible route of transmission.

<table>
<thead>
<tr>
<th>Date</th>
<th>Day of infection</th>
<th>Test</th>
<th>Medical examination</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 2, 2015</td>
<td>7</td>
<td>Heart examination</td>
<td>Tachycardia (189 beats/min; normal range 100–120) with a gallop rhythm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cerebrospinal fluid analysis</td>
<td>Normal leukocyte count with normal differential</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decreased protein levels (136 mg/L; normal range 150–450)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Elevated chloride levels (136 mg/L; normal range 110–122)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Routine blood count</td>
<td>Increased platelet count (382 × 10^9/L; normal range 125–350 × 10^9/L) and elevated leukocyte count (21.62 × 10^9/L, normal range: 3.5 – 9.5 × 10^9/L) with neutrophils representing 65.8% (normal range 40.0%–75.0%) and lymphocytes 28% (normal range 20.0%–40.0%)</td>
<td></td>
</tr>
<tr>
<td>Dec 5, 2015</td>
<td>10</td>
<td>Plasma electrolyte</td>
<td>Hyponatremia (sodium 116 mmol/L; normal range 135–145 mmol/L)</td>
<td></td>
</tr>
</tbody>
</table>
### Medical examination

<table>
<thead>
<tr>
<th>Date</th>
<th>Day of infection</th>
<th>Test</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 6, 2015</td>
<td>11</td>
<td>Physical examination</td>
<td>Tachycardic (pulse 192; normal range 100–120) and hypertensive (blood pressure 170/110 mmHg; normal range 83/55 mmHg)</td>
</tr>
<tr>
<td>Dec 7, 2015</td>
<td>12</td>
<td>Computed tomography scan</td>
<td>No intracranial abnormalities</td>
</tr>
</tbody>
</table>

### Technical Appendix Table 2. Laboratory tests for the rabies virus in a rabies outbreak associated with solid organ transplantation, Changsha, China, 2015–2016 *

<table>
<thead>
<tr>
<th>Patient</th>
<th>Number of saliva samples specimens</th>
<th>Method 1</th>
<th>Outcome 1</th>
<th>Method 2</th>
<th>Outcome 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donor</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Recipient 1</td>
<td>1</td>
<td>RT-PCR</td>
<td>Positive for rabies virus</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Recipient 2</td>
<td>3</td>
<td>RT-PCR</td>
<td>Positive for rabies virus</td>
<td>Whole-genome sequencing</td>
<td>Isolates belong to China I lineages</td>
</tr>
<tr>
<td>Recipient 3</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*NA, not available; RT-PCR, reverse transcription-polymerase chain reaction.