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Hantavirus: A Dangerous Scientific Cruise

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Abstract
Thirteen cases of hantavirus infection (including three deaths) were detected on a cruise ship returning from Ushuaia. Following discussions, the ship was permitted to dock in the Canary Islands, where passengers were disembarked under safety protocols and sent back to their respective countries for medical monitoring. Hantaviruses comprise more than 53 species, each associated with a specific rodent. Humans become infected through the inhalation of excreta in areas frequented by rodents. Hantavirus infections are zoonoses that manifest as hemorrhagic fever with renal syndrome or cardiopulmonary syndrome. The Andes strain, found in South America, is capable of human-to-human transmission. Diagnosis is established via serology or PCR. There is no treatment or vaccine.
Keywords: Hantavirus, Rodents, Zoonoses, Cruise, Hemorrhagic fever with renal syndrome, Cardiopulmonary syndrome

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Introduction

Every year, many people travel on cruise ships. In 2025, 87 million travelers enjoyed cruises, according to the cruise industry. It is therefore not surprising that infections such as gastroenteritis can spread quickly within the confined space of a boat. However, other, rarer infections can also occur.

A few months ago, the Dutch-flagged cruise ship *MV Hondrius* (Figure 1) departed from the port of Ushuaia bound for Cape Verde. However, a stowaway disrupted the voyage: the hantavirus. This incident immediately brought to mind events from a few years ago involving the *Diamond Princess*, a cruise ship stranded in Japan during the early stages of the COVID-19 pandemic. Yet, in this instance, the virus is different, and the risk of transmission appears to be extremely low.

Infection prior to boarding

This ship was not intended for a typical tourist cruise but carried 150 people of 23 nationalities, primarily ornithologists, botanists, cetacean specialists, and history and geography enthusiasts. After Ushuaia, the ship stopped at St. Helena Island, where about thirty passengers disembarked and flew home. At this stop, the first deceased patient was disembarked, and then his wife was evacuated and died shortly afterward. In total, eight patients exhibited various symptoms, and three passengers died (a Dutch couple and a German woman). Given the incubation period, the first case, a Dutch ornithologist who showed initial clinical symptoms three days after boarding, had contracted the infection while searching for rare birds in one of the South American countries visited (Argentina or Chile) before the ship departed from Ushuaia. This sparked international panic. The WHO, in collaboration with Argentina's Malbrán Institute, sent research teams to investigate potential sources of the virus in the locations visited by this patient and oversaw the collection of over 150 samples from various rodents; all tested negative, in particular, the primary virus reservoir the long tailed mouse (*Oligoryzomys longicaudatus*) (Figure 2).

One of our patients—a veterinarian and avid bird photographer—was among the passengers. As soon as the illness on board was announced, he sent an email describing the sanitary measures as strict but "manageable"; according to the passengers, the situation remained calm, and he highlighted the dedication of the crew: a request to remain in cabins as much as possible, permission to move about on the outer decks, avoidance of gatherings, and normal meals while "observing safety distances." Furthermore, different passengers have been contacted by the ministry of Foreign Affairs' crisis unit from their country of origin.

The ship finally docked in Tenerife to disembark passengers from various countries under maximum safety conditions—supervised by a WHO official and without contact with the local population—so they could quickly board the planes that repatriated them to their home countries for medical assessment.

The five French passengers (one of whom is symptomatic)

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have been placed in isolation in tropical unit at Bichat Hospital (Paris) for observation—initially for a minimum of 15 days, followed by 42 days at home. But French health authorities have decided to keep patients in the hospital for 42 days, with a formal ban on leaving their rooms. So far, only one woman is in intensive care (whose strain sequencing did not reveal the emergence of a variant that could potentially have been more dangerous), while the other 25 contact patients have consistently tested negative. Other countries have adopted broadly similar measures, albeit with variations: the UK is using Arrowe Park Hospital for a shorter maximum duration, in military hospital Gomez Ulla (Madrid), in quarantaine cabins erected on the dockside for the crew in Rotterdam, while Australia is using an isolated camp. In the United States, the 17 "contact" patients were placed under observation for a few days before being sent home—though the U.S. Health Secretary is well known for his opposition to such health measures. The final tally shows 13 positive cases and 3 deaths (mortality 27,3%). A total of 149 people on board the ship (passengers and crew) were concerned, as well as 138 close contacts on the planes that carried the passengers who had disembarked on Saint Helena Island.

Following the conclusion of medical monitoring for the 650 "contact cases" identified across various countries, and in the absence of new cases, the WHO officially declared the end of this hanta infectious episode in July 2026.

Multiple viruses involved

The name "Hantan" comes from the Hantan River, located on the border between the two Koreas, where more than 3,000 soldiers were infected during the Korean War (1950–1953). Hantavirus diseases are viral zoonoses caused by various viruses depending on the rodents and regions involved, with each hantavirus being associated with a specific rodent host. Hantaviruses (family *Bunyaviridae*) are spherical RNA viruses measuring approximately 100 nm (Figure 3); there are currently 53 recognized species, comprising over 140 taxa distributed across all continents.

Viral replication proceeds via attachment to the host cell, followed by membrane fusion, transport into the cytoplasm, transcription, replication, and translation of the genome, and release into the circulation (Figure 4) (1).

Many animals serve as natural reservoirs—particularly rodents (rats, voles, brown rats, moles), but also bats, some fish, and even a reptile. These reservoir hosts remain asymptomatic, yet the virus persists throughout their lives in all organs and is consequently shed via excreta. Rodents become infected through direct contact and indirectly through the inhalation of excreta. Various studies in Mexico have shown that 27% of rodents were carriers of hantavirus (2).

There are between 150,000 and 200,000 cases worldwide each year, particularly in South America (3). In Europe, nearly 10,000 cases of hemorrhagic fever with renal syndrome are diagnosed annually, involving six hantaviruses. Each virus has a specific reservoir that varies by region (4): Puumala (vole), Dobrava (wood mouse), Saaremaa (wood mouse), Seoul (black rat), Tula (vole), and Seewis (shrew).

In North America, the Sin Nombre virus (carried by mice) (5), New York virus (mice), Bayou virus (rice rats), and Black Creek virus (cotton rats) are present. The first outbreak of hantavirus pulmonary disease was described

Figure 1. Ship *MV Hondrius*, coming back from Ushuaia, with a cluster of hantavirus

Figure 2. Reservoir of Hantavirus, andes strain, the long tailed mouse (*Oligoryzomys longicaudatus*)

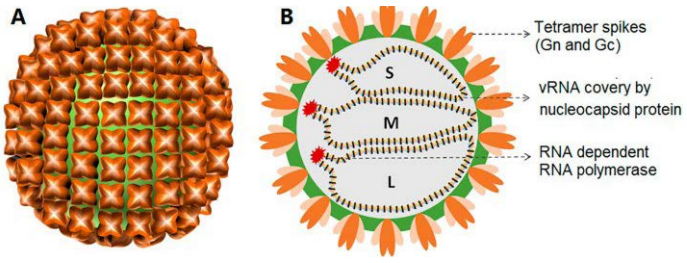

Figure 3. Hantavirus: external (**A**) and interior (**B**) structures with three genomic RNA segments (L, M, and S)

in the United States of America in 1993 (6). In Asia, the Hantaan virus (field mice) causes Korean hemorrhagic fever. In South America, the Laguna Negra virus (mice) and Andes virus (rice rats) are found; the latter is the only virus transmissible between humans through direct contact with bodily fluids (blood, saliva, urine) or through prolonged close contact with an infected patient (7). It is highly likely that global warming will further increase the frequency of contact between humans and wild animals—which serve as reservoirs for as-yet-unknown pathogens (8) (Figure 5).

Two clinical forms

Humans become infected by inhaling dust contaminated with the excreta of infected animals in forests, uninhabited buildings, or fields (Figure 6). Armies on campaign have long been at particular risk. An outbreak involving 1,000 cases occurred in Finland in 1942, during World War II, followed by 129 cases between 1991 and 1995 during the Balkan Wars (9).

Among the various hantaviruses, only one—the Andes virus—is transmitted between humans through close contact, as demonstrated in an outbreak in Argentina with 34 cases, including 11 deaths (10) and there is no vector-borne transmission. In humans, hantavirus infections can manifest in two ways: a viral hemorrhagic form with renal syndrome, caused by an Old World virus, and a cardiopulmonary form, caused by a New World virus (11). In 2012, 10 cases (including 3 deaths) were detected in Yosemite Park. (12). In France, there are three hantavirus species (Puumala, Seoul, and Tula) (13), causing 100 cases of the hemorrhagic form with renal syndrome and 11 cases of the cardiopulmonary form in French Guiana, including four deaths (14). In Panama, a 20-year study recorded 712 cases, resulting in 56 deaths. (Figure 7) with a peak in winter and summer (Figure 8) (15).

Clinical symptoms in patients with hantavirus infection vary widely—ranging from asymptomatic to fatal—and are caused by direct microvascular endothelial injury leading to a vascular permeability and plasma leakage and sometimes acute respiratory distress syndrome (16). European and Asian viruses exhibit renal and hepatic tropism, whereas American viruses show pulmonary tropism. The incubation period averages around two weeks but can extend up to six weeks. Depending on the region, various differential diagnoses must be considered, such as influenza, dengue fever, leptospirosis, malaria, bacterial meningitis, and others.

Hemorrhagic fever with renal syndrome manifests as fever, headache, anorexia, hypotension, abdominal pain, petechiae, and oliguria followed by polyuria, before convalescence sets in after one week (17). Mortality rates range from 0.4% to 15%. A study of 251 cases in Croatia

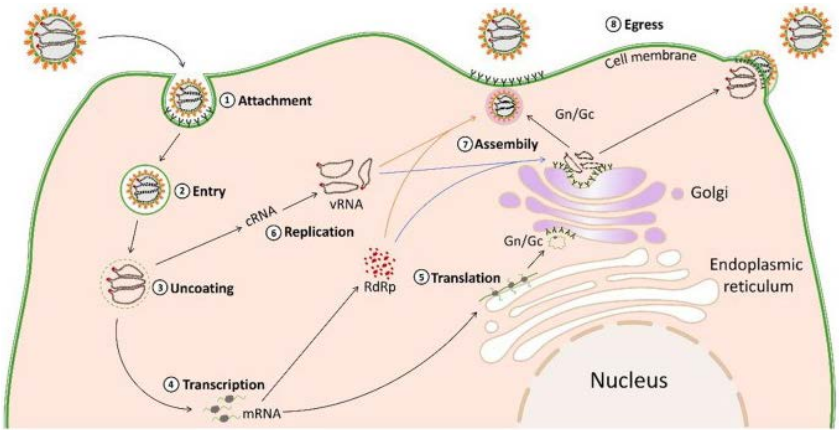

Figure 4. Replication processes of hantaviruses in host cells (in 1)

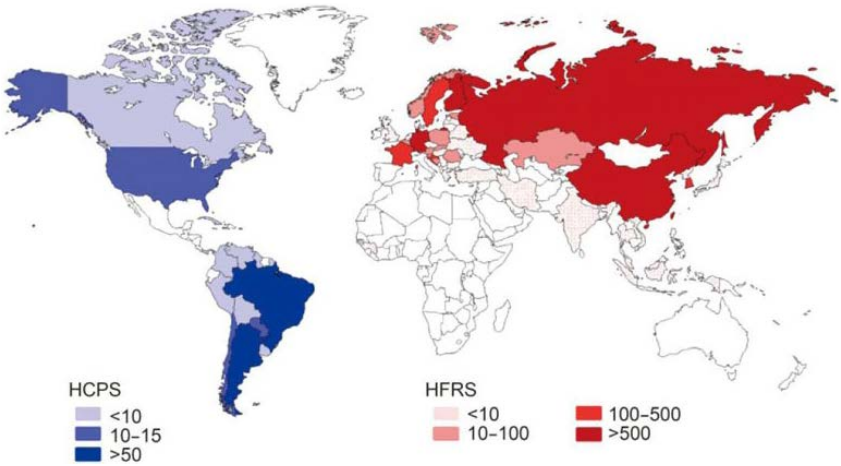

Figure 5. Hantavirus in the world (in 11)

caused by the Puumala virus confirmed the disease's mild course in the majority of cases (Table 1) (18).

The cardiopulmonary form manifests with fever, myalgia, malaise, and abdominal pain, followed by pulmonary edema (Figure 9), hypoxemia, tachypnea, tachycardia, and even cardiogenic shock (19). The lung biopsy confirms intra-alveolar edema (Figure 10). Mortality ranges from 30% to 60% (20, 21).

Several factors appear to be unfavorable: aging host (22) female sex, increased creatinine and hematocrit, and clinical signs of bleeding and the presence of infiltrates on chest X-ray (23, 24).

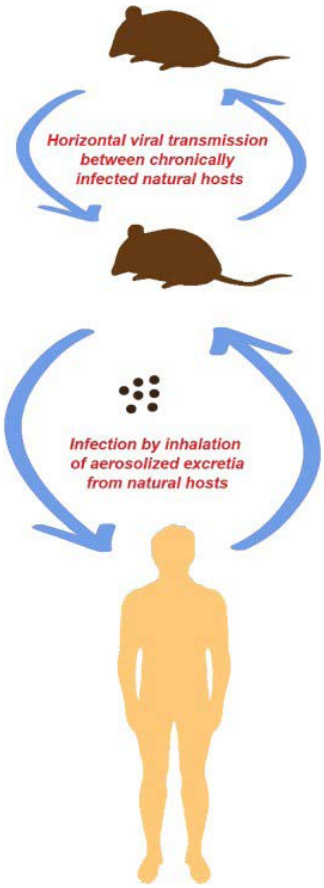

Figure 6. Modes of transmission of hantavirus

In case of pregnancy, the infected pregnant women appear to have more severe clinical symptoms and worse clinical outcomes. The sequelae mainly include menstrual disorders, amenorrhea, no milk secretion after delivery, sexual dysfunction, hair loss, and chronic renal insufficiency Regarding the fetuses, the possible sequelae are congenital heart disease, necrotizing enteritis, restricted growth and development and hydrocephalus (25).

In case of hantavirus with pulmonary syndrome in children, they dye more quickly than adults, mostly with an highest hematocrit and creatinine levels (26). In case of hantavirus infection with renal sydrome, kidney multifocal interstitial hemorrhages are present in kidney biopsies (27).

Early symptoms such as fever, headache muscle aches, nausea, and fatigue are easily confused with influenza. If the initial test is done before the virus can be found, repeat testing is often done 72 hours after symptom start (28) Diagnosis is based on serology (IgM and IgG) using enzyme immunoassay tests and PCR to detect the presence of the virus (29) (Figure 11). Treatment is solely symptomatic. A few trials have been conducted with ribavirin, favipiravir and monoclonal antibodies (30). Convalescent plasma has been tried. Adequate hydration is important to manage oliguria. Dialysis may be required in cases of renal failure (31).

Prevention relies on avoiding all contact with rodents: wearing gloves and masks when handling them, and avoiding areas that have been closed off for long periods (32-37). Rodent control measures are useful. A vaccine is available to a limited extent in China and South Korea, but with mixed results.

Confinement or evacuation?

The ship was quickly identified as a source of hantavirus infection—posing a potential risk of triggering an outbreak—and no country was willing to accept it. However, following discussions with Spanish health authorities, it was permitted to enter the port of Tenerife

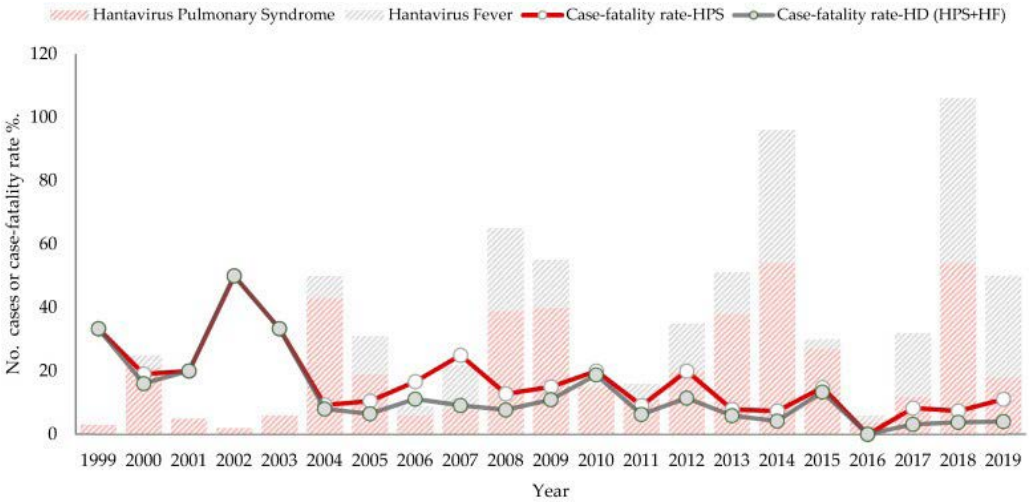

Figure 7. Number of hantavirus disease cases and case fatality rate (HPS, HD) per year, 1999–2019 (Panama) (in 15)

(Canary Islands), on the condition that there be no contact with the local population.

So, two options regarding the management of patients on board the ship quickly circulated. Should the passengers have been confined on the vessel for 42 days—the maximum incubation period—or should they have been repatriated to their countries of origin, as was actually done? From a purely scientific and epidemiological standpoint, confinement in place would have been preferable, keeping the outbreak contained and contacts isolated in a controlled environment to prevent any potential escape of the virus.

However, from a human perspective, isolating a group of people for such a long period was difficult to contemplate, especially given the lack of on-site intensive care facilities. The risk of the virus spreading had already been incurred when passengers disembarked in Saint Helena. Furthermore, Spain was unwilling to risk harboring a "hantavirus cluster" in the Canary Islands, which would have had a major impact on local tourism. Consequently, the decision was made to repatriate the travelers under strict sanitary conditions, with gowns, masks, and caps (Figure 12), followed by care arrangements tailored to each country's specific criteria. After returning to the Netherlands, the ship was thoroughly disinfected and then set sail again with new passengers.

Table 1. Characteristics of 251 patients with hemorrhagic fever with renal syndrome (according to 8)

Sex	**Male 79%, Female 21%**
Age	Mean 45.7 years (15–87 years)
Duration of symptoms	Mean 4.8 days (2–21 days)
Temperature	Mean 38°C (37.4–40°C)
Headache	55%
Lower back pain	46%
Myalgia	39%
Vomiting	30%
Platelet count	Mean 89.97 x10^9/L (6–287 x 10^9/L)
CRP	Mean 89.3 mg/L (7–246 mg/L)
Creatinine	Mean 176.1 µmol/L (44–839 µmol/L)
Moderate course	91%
Severe hypotension	6%
Severe renal outcome (hemodialysis)	1,5%
Death	1,5%

Conclusion

In conclusion, the emergence of this virus—little known to the general public—sparked a wave of panic worldwide. However, the WHO issued sound guidance, and the different governments took the necessary measures to minimize the spread of the disease while keeping the public

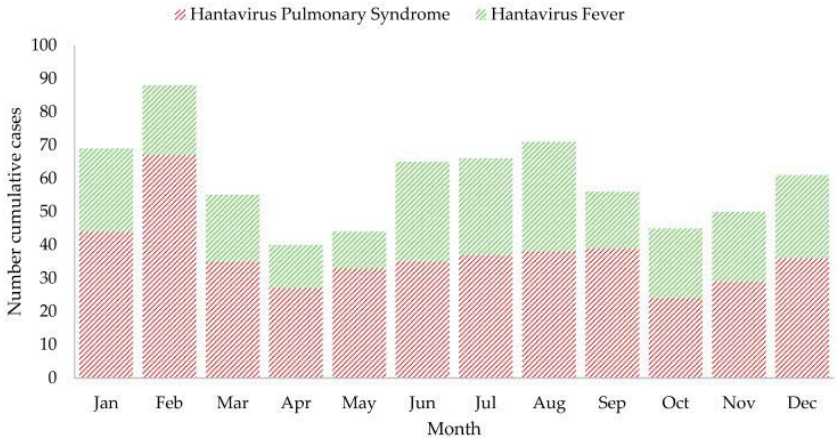

Figure 8. Number of cumulative cases per month of hantavirus disease in Panama, 1999–2019 (in 15)

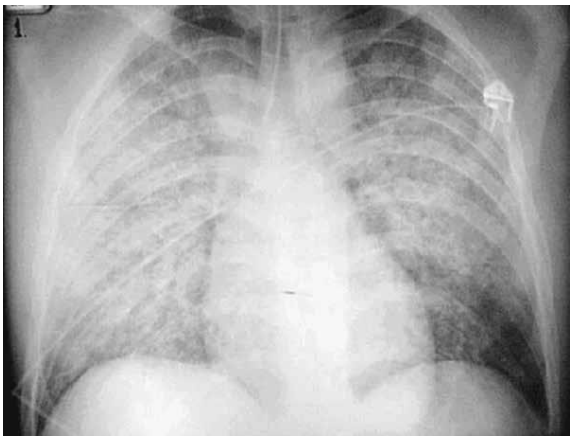

Figure 9. Hantavirus: bilateral pulmonary oedema

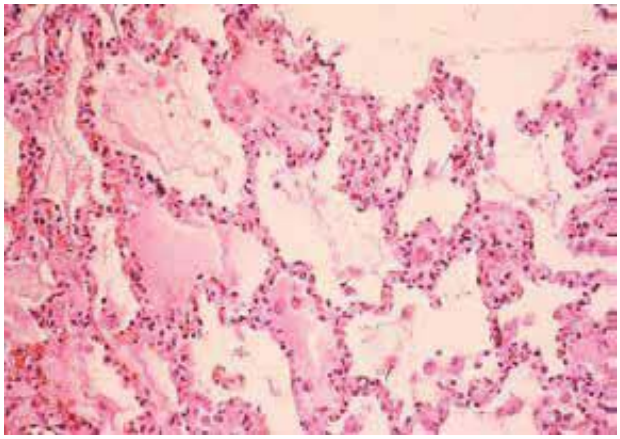

Figure 10. Hantavirus: pulmonary biopsy: intra-alveolar edema

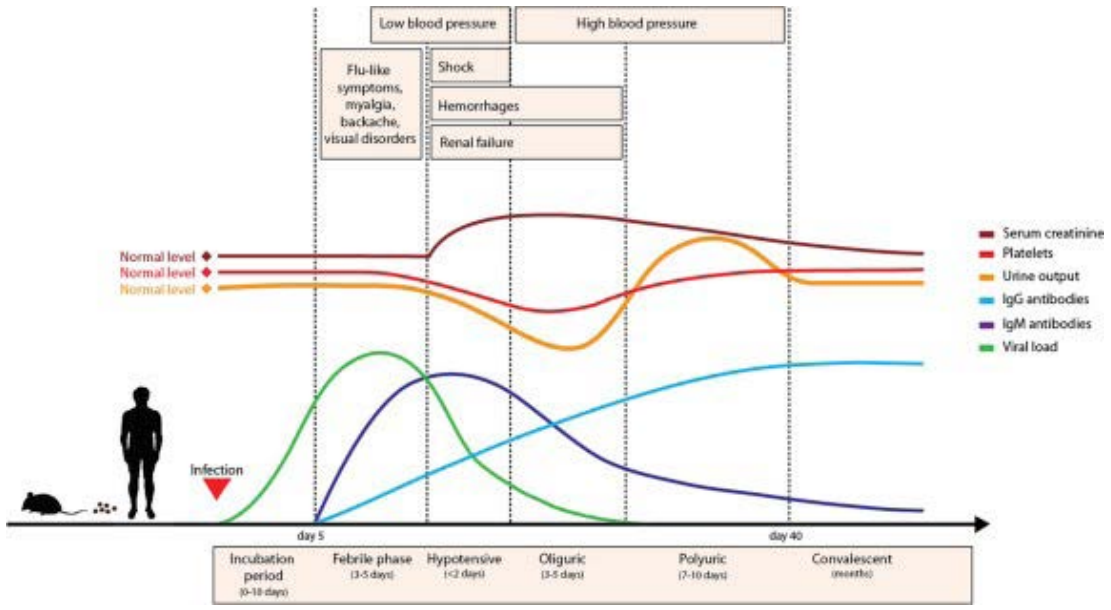

Figure 11. Clinical and biological course of haemorragic fever with renal syndrome (in 4)

Figure 12. Disembarkation of close contacts under strict health precautions

informed about the health status of individuals who had been in contact with patients.

Authors' Contribution

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Investigation: Francine Bisaro, Alireza Ensaf
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Supervision: Patrice Bouree, Yagoob Garedaghi
Validation: Patrice Bouree
Vizualisation: Patrice Bouree, Yagoob Garedaghi
Writing-Original Draft: Patrice Bouree, Francine Bisaro, Alireza Ensaf
Writing-Review & Editing: Patrice Bouree, Yagoob Garedaghi

Competing Interests

The authors have no conflict of interest to disclose

Ethical Approval

Written consent was obtained from the patient from the patient fo the publication of his clinical case

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