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Investigation into a Cluster Infection of Hemorrhagic Fever with Renal Syndrome from a Navy Ship

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Between March and May 2006, three members from a navy ship were reported and diagnosed with hemorrhagic fever and renal syndrome. Serum samples of these three cases were tested positive for Hanta virus antibody and the viral type was confirmed to be of Seoul type. Serum samples of their six family members and 84 co-workers of these cases were negative for antibody against Hanta virus. Norway rats were suspected to be related to the cluster infection of hemorrhagic fever with renal syndrome due to the fact that these three infected cases were all living in the same room on the ship, and Hanta virus of the Seoul type were identified from both Norway rats captured on the ship and the two harbors that the ship had parted. The three cases might be infected by contact with or inhalation of air-born particles contaminated with Hanta virus from waste products of Norway rats. No more cases of hemorrhagic fever with renal syndrome were reported after a period of disease control and prevention with cleaning, disinfecting the ship, blocking food sources for the rats, and executing infected rats. It proves that termination of rats is an effective measurement against hemorrhagic fever with renal syndrome.

Introduction

Hanta virus infection is a category two infectious disease in the law for prevention of infectious disease. Hanta virus infection is mainly caused by rodents [1-3]. Symptoms of Hanta virus infection are mainly separated into renal syndrome and pulmonary syndrome [1]. The former refers to hemorrhagic fever with renal syndrome (HFRS), in which the infected person will have symptoms including sudden onset of persistent fever for 3 to 8 days, conjunctival injection, general weakness, back pain, headache, abdominal pain, anorexia, and nausea. Hemorrhagic symptoms usually occur on the third to sixth day, followed by proteinuria and hypotension. Shock may occur in some people. The renal symptoms ranged from mild to severe such as acute renal failure [1, 4]. The

later is Hanta virus pulmonary syndrome (HPS). Symptoms at the onset of the disease are non-specific, including fever, malaise and severe myalgia (especially at the thighs, buttocks, and back). Most patients will also have headache, gastralgia, nausea, vomiting, dizziness, or chills. Cough and dyspnea usually starts from day 4 to day 10 after the onset of the disease. The disease might progress to respiratory failure and shock once cardiopulmonary symptoms occur [1, 4].

There are mainly four types of viruses causing HFRS: Hanta virus, Seoul virus, Puumala virus, and Dobrava virus [4]. In Taiwan, Hanta viruses leading to HFRS mainly survive in eight rodent species including *Rattus norvegicus*, *R. rattus*, *R. flavipectus*, *Bandicota indica*, *R. losea*, *Apodemus agrarius*, *Mus musculus*, and *Suncus murinus*. Humans are accidental hosts [4]. According to the literature, HFRS mainly occurs in Asia (China, Korea, and Thailand) and European countries [2, 5-8], and HPS mainly occur in South and North America [9-10]. Most cases of Hanta virus infection are sporadic cases, cluster events usually occur in endemic areas [11-12]. In this article, we reported a small scale of HFRS cluster event in Taiwan caused by Seoul type virus possibly through contact or inhalation of waste products from Norway rats, its subsequent investigations and management.

On April 29, 2006 around 9 PM, Department of Health of Taipei City Government received a report from Taipei Medical University Hospital stating that a soldier (case B) serving on a Navy ship at sea port B was a case of HFRS. His serum sample confirmed the presence of Hanta virus by the Laboratory Research and Development Center, Centers for Disease Control, Department of Health. Serum IgM and IgG were all positive. Hence, health surveillance was conducted to investigate whether other people were also infected by Hanta virus. In addition, infection source and route would need to be identified via epidemiological investigation. Finally, the results of prevention and surveillance should be assessed to prevent the disease from spreading.

Disease surveillance

From 29th of April to 1st of May 2006, three identified cases were confirmed to be HFRS. Their symptoms, time of onsets, travel and contact history will be described below.

Case A

Case A is a 27-year-old male. He began to serve on a Navy ship since middle March, 2000. He was on a vacation between March 15 and 22, 2006. On March 15, he started to experience general discomfort, having symptoms of fever, nausea, myalgia, and chills. Even though he was seen by a medical officer on the ship, he went to a hospital around his home in Kaohsiung on March 16 with improvement. During the period of disease surveillance, Case A was conscious clear with no apparent discomfort. Between April 5 and 12, he went back to his home in Tzuo-Ying, Kaohsiung for vacation again but did not return thereafter. Case A was living with his younger brother, who did not experience any discomfort.

Case B

Case B is a 24-year-old male, who served at the same Navy ship. His daily activities were usually done on the ship. The case was in good health with no special medical history. He shopped briefly around seaport A on Match 10 and also around seaport B where he could not remember which date. From the evening of April 12 to midday of the 19th, the case was home for vacation for a week. His four family members were all negative for suspected symptoms of HFRS. The case had a dog at home but there was no trace of rats. He did see rats on the ship previously, but could not remember whether he had contacted or inhaled any waste products from rats, or being bitten by rats. Between April 19 and 21, he had fever but no proper temperature was taken. On April 26, he experienced intermittent upper abdominal discomfort, hence took the 8pm flight that night back to Taiwan. He was accompanied by his family to Taipei Medical University Hospital where fever, generalized aches and pain, liver and renal

impairment, and thrombocytopenia were diagnosed. On April 27, HSRF was reported.

Case C

Case C is also a 24-year-old male, working on the same ship as Case A and B as a maintenance worker. On May 2, he started to have fever (39℃), headache, and anorexia. He went to a military hospital at seaport B and got admitted. He was subsequently transferred to Tri-service General Hospital on May 3 since there was no improvement of symptoms, and was quarantined. Laboratory results from the Tri-service General Hospital showed leukocytopenia (3,500/μl) and thrombocytopenia (61,000/μl). During the period of March 20 to 30 and April 21 to 28, case C had returned home for holiday in Nan-Tzi, Kaohsiung. He had spent his other vacations mainly around seaport B, and had never visited other tourist places nearby. He claimed that he had never been bitten by rats neither did he know any previous contact or inhalation of rat's waste products.

Epidemiology surveillance

Despite the earliest date of onset (March 15), case A was not diagnosed with HSRF at the time. Case B and C started their symptoms on April 19 and May 2 respectively, sharing symptoms of fever and thrombocytopenia. Serum samples from the 3 cases were all positive for IgM and IgG against Seoul type Hanta virus. Although the three cases were living in different residences, they all served on the same ship, and sharing the same room. It indicated the possibility that they could all be infected in the same room. It was unlikely that they got the disease at home and seaport A. Even though the date of onset from one to another all fell within the range of incubation period of HSRF (generally 12 to 16 days, but could vary from 5 to 42 days), that fact that HSRF was not transmitted from human to human [4,13] plus the timing of contact with rat's waste products was not clear, it was impossible for us to estimate the incubation period. Hence, we could only conclude that these three cases were related epidemiologically in

person and place.

Gathering and examination of human specimens

Serum samples of the 3 cases were examined by the Laboratory Research and Development Center of the CDC, Department of Health using Enzyme-Linked Immunosorbent Assay (ELISA) and confirmed positive for IgM and IgG against Seoul type Hanta virus. For case A and B, only serum samples from the recovery phase were obtained. Hence, PCR could not be done. However, titers of IgM and IgG were very high. Serum sample from case C was positive for Hanta virus by PCR, and the titer of antibody increased from zero to 4-fold. Six family members of the cases (1 of case A, 4 of case B, and 1 of case C) and other 84 people served on the ship were all negative for antibodies against Hanta virus.

Rat surveillance and sample gathering

During the period of surveillance, devices were places around seaport A, the maintenance building at seaport B and on the ship to capture rats. Four *R. norvegicus* species and one *S. murinus* species were captured, and only one *R. norvegicus* species was positive for Seoul type Hanta virus. Four *S. murinus*, three *R. norvegicus* and one *R. rattus*, and two *R. norvegicus* were also positive for Seoul type Hanta virus. Four *R. norvegicus* and one *R. Rattus* were captured on the ship, and two *R. norvegicus* were positive for Seoul type Hanta virus. In total, 5 rats were positive for Seoul type Hanta virus, which was identical to the virus identified from the three cases. We therefore suspected that *R. norvegicus* might be related to this cluster event of HSRF. *R. norvegicus* and *S. murinus* were all negative for Seoul type Hanta virus.

Prevention

After the occurrence of HSRF, health authorities required all people on the ship to be monitored for temperature and health status, until one month (two times of the incubation period) after the onset of the last case. Suspected cases having

HSRF symptoms should be reported and admitted to hospitals. Simultaneously, the fifth branch of the CDC provided 50 kg of baits, 120 rat capture plates, 400 bottles of bleach and 480 bottles of disinfectant for use. Environmental Protection Bureau, Public Health Bureau of Penghu County and the military camp offered manual labor to disinfect and terminate rats on the ship, the maintenance building at seaport B and surrounding areas. Workers participating in the processes were required to wear protective devices (gloves, surgical masks). Cages for capturing rats and 200 packs (50 g/pack) baits for rat termination were placed around seaport A. Rat carcass were gathered by patrols, who wore proper protective devices, picked up rat carcass into double disposal bags, added in disinfectants, and handed them to Environmental Protection Bureau to be buried. Besides, management of kitchen disposals was strengthened and soldiers were prohibited to carry foods from outside to the ship in order to eliminate food sources for rats. Finally, four training courses for prevention of Hanta virus infection were held by the CDC for people working on the ship and around the seaport areas to strengthen knowledge of HSRF and its prevention measurements.

Conclusions

Among 87 people served on the ship, 3 were confirmed to have HSRF, with an attack rate of 3.4%. Seoul type Hanta virus was isolated from serum samples of both the infected cases and rats captured on the ship. Seoul type Hanta virus was therefore confirmed to be the pathogen lead to this HSRF cluster event. *R. norvegicus* is likely to be the host of Seoul type Hanta virus, and its waste products should be the cause of infection.

Two months prior the onset of the disease, the ship had never sailed to other areas. It anchored at seaport A on March 14, and left for seaport B on the same day. Case A started to have symptoms on March 15, and Seoul type Hanta virus was confirmed on May 3. Since *R. norvegicus* captured on the ship and seaport A was all positive for Hanta virus, it was likely that case A was infected by Hanta

virus at seaport A or on the ship. Since case A already had the disease before entering the maintenance building at seaport B, despite rats at seaport B were positive for Seoul type Hanta virus, the building could still be excluded as the infection source of Seoul type Hanta virus for case B an C. In addition, serum samples from family members of the three cases were all negative for Seoul type Hanta virus, indicating that the chance was extremely low for Hanta virus to transmit between people. It was also unlikely for the three cases to be infected by Seoul type Hanta virus at home, and then started to have symptoms on the ship. Hanta virus could not be transmitted via insects such as fleas, ticks, and mosquitoes. The chance for three cases to be bitted by *R. norvegicus* was low. It was more likely that they were infected by contacting or inhaling waste products (urine, feces or saliva) of *R. norvegicus* carried with Hanta virus. The three cases lived together in the same room on the ship, which meant 3 out of 10 people in that room were infected. In addition, two *R. norvegicus* captured on the ship were positive for Seoul type Hanta virus, suggesting that the room was the main infection source of Hanta virus. However, we did not investigate the room thoroughly to understand how the three cases were infected.

In terms of prevention, we have to understand that HSRF is not transmitted from human to human, and hence monitoring body temperature and heath status should start from the date of disinfection and termination of rats on the ship, rather than the onset of symptom of the last case. Monitor should last for a certain period, such as two times of the incubation period before it ends. No HSRF cases were reported after disinfection and termination of rats on the ship, indicating that rat termination is an effective measurement to stop occurrence of HSRF. Since Hanta virus is transmitted by air-born rat droppings, the ground should be rinse first with disinfectant to avoid dusts before cleaning area with rats. At the same time, workers responsible for cleaning the rat-containing areas should wear masks having HEPA filters, not ordinary surgical masks. The investigation into this cluster infection has provided us with a precious experience, that is, all

ships from now on should conduct rat extermination periodically to prevent HSRF from happening again.

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