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Research note

Extensive severe fever with thrombocytopenia syndrome virus contamination in surrounding environment in patient rooms

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ABSTRACT

Objectives: Severe fever with thrombocytopenia syndrome (SFTS) is an emerging tick-borne disease in Korea and China. Although there is previous evidence of person-to-person transmission via direct contact with body fluids, the role of environmental contamination by SFTS virus (SFTSV) in healthcare settings has not been established. We therefore investigated the contamination of the healthcare environment by SFTSV.

Methods: We investigated the possible contamination of hospital air and surfaces with SFTSV transmission by collecting air and swabbing environmental surface samples in two hospitals treating six SFTS patients between March and September 2017. The samples were tested using real-time RT-PCR for SFTS M and S segments.

Results: Of the six SFTS patients, four received mechanical ventilation and three died. Five rooms were occupied by those using mechanical ventilation or total plasma exchange therapy in isolation rooms without negative pressure and one room was occupied by a patient bedridden due to SFTS. SFTSV was detected in 14 (21%) of 67 swab samples. Five of 24 swab samples were obtained from fomites including stethoscopes, and 9 of 43 were obtained from fixed structures including doorknobs and bed guardrails. Some samples from fixed structures such as television monitors and sink tables were obtained in areas remote from the patients. SFTSV RNA was not detected in five air samples from three patients' rooms.

Conclusions: Our data suggest that SFTSV contamination was extensive in surrounding environments in SFTS patients' rooms. Therefore, more strict isolation methods and disinfecting procedures should be considered when managing SFTS patients. **B.-H. Ryu, Clin Microbiol Infect 2018;▪:1**

Introduction

Severe fever with thrombocytopenia syndrome (SFTS) is an emerging tick-borne disease in East Asia, which is transmitted by certain ticks such as *Haemaphysalis longicornis* [1]. The mortality rate associated with SFTS has been reported as high as 30% [1]. Although several types of experimental therapies have been tried [2,3], there is no recommended treatment for SFTS. Because SFTS is a fatal viral haemorrhagic fever, preventing person-to-person transmission has become an important issue in terms of public health. In addition, given our previous study demonstrating nosocomial transmission from a fatally ill patient with SFTS to healthcare workers [4], appropriate isolation and precaution are important for infection control. Early in the discovery of SFTS, the risk of person-to-person transmission was thought to be low [1]. However, recent studies have reported that various body fluids including urine and tracheal aspirate contained SFTS virus (SFTSV) [5] and direct contact with a patient's blood or body fluids can be a potential source of SFTS transmission [4,6]. Furthermore, a recent China study reported two probable cases of SFTS by aerosol

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transmission [7]. However, there are limited data on the role of environmental contamination by SFTSV in healthcare settings. Therefore, we investigated the environmental contamination of air and of accessible/inaccessible surfaces in two hospitals treating six patients with SFTS.

Materials and methods

Patients and study sites

Six patients were diagnosed with SFTS using RT-PCR performed by the Korea Centres for Disease Control as described previously [4]. Blood samples from these patients were obtained in two hospitals, Asan Medical Centre, Seoul (northern Korea), and Gyeongsang National University Hospital, Jinju (southern Korea), from March to September 2017. The plasma SFTS viral load was analysed by real-time PCR for the S and M segments of SFTSV in all patients as described below. Of the six patients with SFTS, five were admitted to an intensive care unit (ICU) owing to a deteriorating clinical course, and the remaining patient was admitted to the general ward. All patients' rooms were standard isolation rooms without negative pressure. Air and environmental samples were collected from each patient's room. Additional air samples were taken from the corridor adjacent to the patient's room. The air and environmental samples were tested using real-time PCR for SFTS M and S segments.

Environmental sample collection

Environmental samples were collected at different time-points during the hospital stay. An MD8 airscan sampling device (Sartorius, Goettingen, Germany) and sterile gelatin filters (80-mm diameter and 3-μm pores; Sartorius) were used to sample air at a speed of 50 L/min for 20 min in the patients' rooms and adjacent corridors. The filters were dissolved aseptically in 30 mL of viral transport medium containing sterile PBS with 1% bovine serum albumin (Sigma, St Louis, MO, USA), 1% antibiotic and antimycotic solution (10,000 U/mL penicillin, 10 mg/mL streptomycin, 25 mg/L amphotericin B; Sigma), and stored at − 80 °C until analysed.

Dacron swabs pre-moistened with 3 mL of viral transport medium (Copan, Murrieta, CA, USA) were used to swab surfaces aseptically. The following types of surface were swabbed: (a) fomites (i.e. stethoscopes, bag valve masks, blood pressure cuffs, nasal prongs, suction circuits, glasses, pillows, disposable towel boxes, infusion pumps, head monitors, ventilator monitors and continuous renal replacement therapy monitors); (b) fixed structures in the rooms (i.e. doorknobs, bed guardrails, the head and foot of the bed, bed controller, window frames, light switches, television monitors, walls, shelves, exhaust pipes and sink tables). Even surfaces remote from the patients such as television monitors and sink tables were swabbed, even though healthcare workers do not normally come into contact with television monitors because of their high position and remote control.

Daily cleaning and disinfection of the rooms with 0.1% hypochlorite solution were performed before sampling. The standard room cleaning procedures included wiping the room equipment and the floor with a sponge or mop.

Laboratory procedures

Viral RNA was extracted from plasma of patients with confirmed SFTS and samples of air and surface swabs were dissolved in viral transport medium using a QIAamp Viral RNA kit (Qiagen Inc., Chatsworth, CA, USA) according to the manufacturer's instructions.

The preparation of SFTS viral RNA transcript controls and performance of multiplex real-time RT-PCR assays were conducted as in our previous studies [8]. The detailed procedures are described in the Supplementary material (Appendix S1, Fig. S1, Table S1). This study was approved by the institutional review board of our hospital.

Results

Clinical features of patients

The patient case status and environmental test results in the two hospitals are summarized in Table 1. Of six patients, five were admitted to an ICU. Another patient was admitted to a medical ward. Three patients recovered, but three patients died of multiple organ failure despite continuous renal replacement therapy and total plasma exchange therapy.

Surface swab samples and air samples

SFTSV was detected in 14 (21%) of 67 swab samples using RT-PCR: 5 in 24 fomite swabs and 9 in 43 fixed-structure swabs. It is noteworthy that all positive environmental samples were obtained from the three patients who died, whereas the environmental samples from the remaining three patients were all negative. In addition, two of three swabs obtained from television monitors and three of five swabs obtained from sink tables were positive for SFTSV despite being remote from the patients (patients 1, 3 and 6).

To examine the possibility of airborne transmission of SFTSV, air samples were tested using RT-PCR. Five air samples collected in three patients' rooms were negative for SFTSV.

Discussion

Although previous studies suggested that SFTSV may be transmitted by direct contact from person to person [4,6], to our knowledge, there are no studies on fomites or contaminated surfaces as possible transmission routes of SFTSV. Our study clearly demonstrated that extensive environmental contamination of SFTSV occurred in rooms of critically ill patients with SFTS. Therefore, our findings provide important evidence for the role of environmental contamination by SFTSV in healthcare settings, emphasizing the importance of strict contact precautions and appropriate disinfecting procedures in the rooms of patients with SFTS.

SFTSV was detected only in the surroundings of the three SFTS patients who were admitted to an ICU and subsequently died. These findings are consistent with a previous report that various body fluids, including gastric aspirate, tracheal aspirate and urine, revealed positive SFTSV PCR results in an SFTS patient who died [9] and most human-to-human transmission cases occurred from such SFTS patients [4,6,9]. Interestingly, SFTSV was detected in areas that were relatively remote from the patients, such as the sink table and the top of the television. Positive results in samples from sink tables located remote from the patient may be explained by the healthcare workers washing their hands and pouring waste from the patient into the sink. However, the television in each room of the ICU was located at a height of 2 m and operated with a remote control without daily cleaning and disinfection. Hence, healthcare workers who contacted the infected patient would not touch the top of the television monitor. One possible explanation for this observation could be that aerosolized virus particles due to oral cavity/tracheal suction during ventilator application could reach areas remote from the patient. However, negative SFTSV PCR results from air sampling contradict this hypothesis, although our negative

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