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Measles, Rubella, and Varicella Among the Crew of a Cruise Ship Sailing From Florida, United States, 2006

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See the Editorial by Clara Schlaich, pp. 207–209 of this issue.

Background. Cruise ship outbreaks of vaccine-preventable diseases (VPD) such as rubella and varicella have been previously associated with introduction and spread among susceptible crew members originating from countries with endemic transmission of these diseases.

Methods. During February to April 2006, we investigated a cluster of rash illnesses due to measles, rubella, or varicella on a cruise ship sailing from Florida to the Caribbean. Case-finding measures included review of medical logs, active surveillance for rash illness among crew members, and passive surveillance for rash illness in the ship's infirmary lasting two incubation periods from the last case of measles. Passengers with potential exposure to these VPD were notified by letters. All susceptible crew members with potential exposure were administered the measles, mumps, and rubella vaccine after informed consent.

Results. A total of 16 cases were identified only among crew members: 1 rubella, 3 measles (two-generation spread), 11 varicella (three-generation spread), and 1 unknown diagnosis. Of 1,197 crew members evaluated, 4 had proof of immunity to measles and rubella. Based on passive surveillance, no cases were identified among passengers, the majority of whom resided in the United States.

Conclusion. The international makeup of the population aboard cruise ships combined with their semi-enclosed environment has the potential to facilitate introduction and spread of VPD such as measles, rubella, and varicella onboard and into communities. Cruise lines should ensure crew members have evidence of immunity to these diseases. Passengers should be up to date with all vaccinations, including those that are travel-specific, prior to embarking on cruise travel.

To prevent the introduction and spread of communicable diseases in the United States, the Centers for Disease Control and Prevention (CDC) operates 20 quarantine stations (QS) located at major US ports of entry and land border crossings.[1] Under federal quarantine regulations, US-bound international conveyances, including cruise ships, are required to report to CDC QS all onboard incidents of deaths and febrile illnesses suggestive of communicable diseases with a potential to spread via the traveling population and adversely impact the public's health. In collaboration with state and local health departments and conveyance operators, such reports are received and investigated by the CDC QS closest to the arrival port.[1] These efforts are consistent with the revised (2005) International Health Regulations, which require surveillance and response to public health threats at ports with minimal interruption of travel andtrade.[2]

On February 17, 2006, a cruise line notified the CDC Miami Quarantine Station about a case of febrile rash illness in a 23-year-old Ukrainian crew member, who boarded the cruise ship to work in food services and 13 days later became ill with a febrile rash illness diagnosed by the ship's physician as acute rubella. Serologic testing, however, confirmed an acute measles infection [positive anti-measles immunoglobulin M (IgM)] and immunity to rubella. On February 20, the Brevard County (Florida) Health Department (BCHD) notified the CDC Miami Quarantine Station of a second case of acute rash illness on the same ship; a 35-year-old

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Filipino crew member had boarded the ship to work in youth activities, and 9 days later developed a rash illness, requiring evaluation in the ship's infirmary. Serological testing confirmed acute rubella infection (positive anti-rubella IgM).

This report describes the public health investigation and control measures in response to these two cases of vaccine-preventable diseases (VPD), both of which have achieved the goal of elimination in the western hemisphere in recent years, highlighting the potential for ongoing transmission and spread of VPD through cruise travel and the importance of ensuring immunity of crew and passengers before embarkation.[3,4]

Methods

On February 26, CDC and BCHD personnel began to assist the ship's medical staff to ensure isolation of cases; find additional cases of measles and rubella, which included implementation of active surveillance for rash illness among crew members; notify passengers of the potential risk of rubella or measles exposure onboard; and identify and vaccinate susceptible crew during the limited time (1 d) that the ship was in port.

Shipboard case-finding measures consisted of retrospective review of the crew and passenger medical logs for rash illnesses or diagnoses of measles or rubella; active surveillance for rash illness among crew members whose supervisors queried them daily about the presence of fever or rash; and passive surveillance by ship's medical staff for rash illnesses among crew members and passengers presenting to the ship's infirmary. These surveillance activities were continued for two incubation periods of measles (ie, 36 d) after the last identified measles patient was isolated on March 4.

Notices about measles and rubella exposure risks were distributed to approximately 30,000 passengers who either sailed on the ship during the cases' infectious periods or who planned to sail during one incubation period (18 d) after isolation of the last measles case, with a recommendation to self-monitor for symptoms if nonimmune and information on measles, mumps, and rubella (MMR) vaccine and risks to pregnant women. Embarking passengers who said they were pregnant were counseled by the ship's medical staff about risks of rubella infection during pregnancy. Pan American Health Organization (PAHO) and US state and local health departments were also notified of potential rubella and measles transmission on this cruise ship.

Because up to 50% of rubella cases may occur without rash or other symptoms yet be infectious,[5] all 1,197 crew members were considered potential contacts based on the congregate nature of their social (ie, shared cabins, social gatherings) and work environments. They were all assessed for immunity to measles and rubella by interview and review of medical records for proof of immunity (ie, vaccination or documented immunity by serology). Serologies for measles and rubella were drawn on persons with contraindication to the MMR vaccine (eg, pregnancy). The Council of State and Territorial Epidemiologists case definitions for measles and rubella were used.[6] Because no international standards for assessment of proof of immunity existed, the US Advisory Committee on Immunization Practices recommendations were applied.[7]

Results

The cruise ship carried approximately 3,100 passengers, primarily from North America, and 1,200 crew members from around the world, sailing on 7-day voyages to the Caribbean. During February 25 to April 14, 14 additional rash illness cases were detected only among crew members: one through medical record review and 13 through passive surveillance in the ship's infirmary (Figure 1).

During the onboard medical log review, a case of probable varicella was identified in a 23-year-old Filipino crew member, who boarded the ship to work in food services, and 22 days later was diagnosed with varicella in the ship's infirmary. Thirteen crew members visited the infirmary with a rash illness. Of these, two met the case definition for confirmed measles (one by serology, and one by clinical diagnosis by the ship's physician and epidemiologic link to the confirmed case); ten met the Council of State and Territorial Epidemiologists case definition for varicella[8] (six were confirmed by clinical characteristics and an epidemiologic link, and the remaining four were probable cases by clinical diagnosis only); and one case of rash illness remained undiagnosed and did not have laboratory evidence of acute rubella or measles and did not meet the case definition for measles, rubella, or varicella (Figure 1). The two additional cases of measles were among crew members employed in food services or entertainment; the additional varicella cases occurred among crew members from various shipboard occupations (ie, food services, galley, housekeeping, engineering, and entertainment). All these cases were

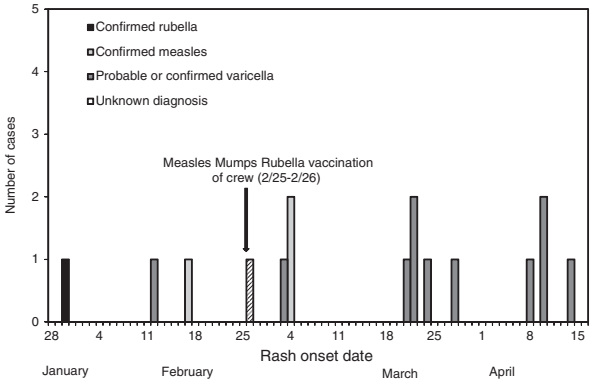

Figure 1 Number of rash illness cases among crew members aboard a cruise ship—Florida, January 28, 2006–April 15, 2006.

among crew members who had been aboard the ship for at least one incubation period of either measles or varicella.

Of 1,197 crew members evaluated for proof of immunity, 3 had proof of immunity to measles and rubella based on vaccination records. During pre-immunization counseling, three crew members were found to be pregnant; of those, one had serological evidence of immunity to rubella and measles and two were susceptible and disembarked for clinical monitoring because of their exposure to rubella. The remaining 1,191 crew members received the MMR vaccine after giving informed consent. The MMR vaccine was supplied by BCHD (with cost reimbursement from the cruise line), whose nursing staff performed counseling and administration of the vaccine.

Close contacts of varicella cases were defined as those having ≥ 5 minutes of face-to-face contact with the case during the infectious period (1–2 d before rash onset until lesions crust or 6 d after rash onset).[9] Contacts meeting this definition were identified only among crew members (eg, crew roommate and workmates) and those who were susceptible[9] were monitored for onset of fever or rash for 21 days after their last exposure to a varicella case. To suspend continued varicella transmission, with the detection of third generation cases, the cruise line also offered the varicella vaccine to susceptible contacts.

These clusters of rash illness ended in April 2006, with a total of 16 cases among crew members: 1 rubella, 3 measles (two-generation spread), 11 varicella (three-generation spread), and 1 undiagnosed case. No cases of rash illness including rubella, measles, or varicella were detected in passengers of this ship based on passive surveillance measures. The BCHD estimated a total cost of $67,000 spent on vaccinations, supplies, and health department staff time (ie, excluding CDC and cruise line staff time) to interrupt transmission (Florida Department of Health, unpublished data, 2006).

Although this outbreak occurred in 2006, CDC continued to receive reports of these VPD on cruise ships arriving at US ports; for example, during May 2006 to December 2010, 2 confirmed rubella cases and 1 suspect measles case, all among crew members, were reported to CDC (CDC, unpublished data, 2010).

Discussion

Cruise travel continues to gain popularity, with a 7.2% annual average passenger growth rate in the North American cruise industry since 1990.[10] In 2009, 9.4 million of the 13.4 million cruise ship voyages worldwide were made by persons who resided in the United States, where Florida had the busiest ports.[10] Despite high levels of immunity to measles, rubella, and varicella among US residents,[11] clusters of some of these VPD on cruise ships originating in the United States continue to occur.[3,12] These clusters are often associated with the introduction and spread of VPD among susceptible crew members from countries with differing epidemiology of disease (ie, varicella), with low immunization rates, or that have not introduced or just recently introduced the vaccine and have ongoing disease transmission. The semi-enclosed, densely populated environment of cruise ships has been documented to facilitate person-to-person transmission of communicable diseases, including VPD such as rubella and varicella.[3,12,13]

The clusters of VPD on this cruise ship resulted from an imported case of rubella from the Philippines, an imported case of measles from Ukraine, and a varicella case of unknown source country, demonstrating the potential for exposure to diseases during cruise travel, which may be more common in developing countries without routine vaccination programs or continuing endemic transmission.[3,4] The outbreak was confined to crew members, of whom less than 1% had proof of immunity to measles and rubella. Similarly, in a previous rubella outbreak investigation on cruise ships, approximately 85% of 366 crew members tested were born outside the United States (representing 50 countries), and 75% lacked proof of immunity to rubella. A serosurvey showed 4% of (366) crew members were acutely infected and 7% were susceptible to rubella.[3] Of 3,643 passengers surveyed 75% were US-born, 33% were of childbearing age, and 0.8% were pregnant. As with the investigation described in this report, although the immune status of passengers was not known, no transmission was detected among them. However, based on a nationwide serosurvey, an estimated 8%–10% of women of childbearing age in the United States are seronegative to rubella, highlighting the potential risk of infection in this subgroup during travel. Up to 85% of infants born to women infected with rubella in their first trimester of pregnancy suffer serious birth defects.[5,14]

The sustained varicella transmission among crew members with different occupations suggested close interactions outside the work environment and high susceptibility rates. A past cruise ship varicella outbreak investigation found <1% of crew members were acutely infected with varicella and 12% were susceptible.[12] The majority of crew members were from tropical countries, where the epidemiology of varicella differs from that of the United States,[5] and were estimated to be two to three times more susceptible to varicella than an age-comparable US-born population.[12] Other recent studies have also documented varicella susceptibility among crew members originating from tropical countries[15,16] and one study suggested that testing cruise members for immunity to varicella, followed by vaccination if necessary, is a cost-effective prevention measure.[16]

This investigation had a limited ability to accurately determine the risk to passengers in whom no VPD cases were detected based on passive surveillance alone. In addition, the number of varicella vaccines administered by the cruise line to crew members because of ongoing transmission was not ascertained. Despite these limitations, this investigation demonstrated the large effort and resources required to implement

surveillance, alert passengers, and vaccinate crew members to halt transmission of VPD among crew and prevent spread to passengers. Although no cases were detected among passengers, the potential for infection existed among those who were susceptible, emphasizing the importance of ensuring immunity to these VPD, especially measles and rubella, among both crew and passengers. The World Health Organization Region of the Americas has interrupted transmission of endemic measles and rubella, achieving the 2000 measles and 2010 rubella and congenital rubella syndrome elimination goals. However, recent outbreaks of measles in the United States resulting from importation, have demonstrated the ongoing threat of international introduction and transmission of VPD among susceptible individuals.[17] Because of upcoming sporting and cultural events in the Americas, the PAHO recently urged all travelers to ensure immunity to measles and rubella before arriving in the region.[18] This message is also relevant to all persons aboard cruise ships, as evidenced by ongoing reports of measles and rubella cases received by CDC QS since 2006.

To sustain measles and rubella elimination efforts and reduce the risk of introduction and spread of VPD in communities through cruise travel, during pretravel preparation, travelers and their health-care providers should ensure that all routine vaccinations are up to date; travelers should also receive any relevant travel-specific vaccinations with consideration to potential exposures onboard the ship and at port stops.[4] In addition, to prevent the occurrence of VPD aboard cruise ships, cruise lines should ensure that before embarking on cruise ships all crew members have adequate proof of immunity to VPD (eg, vaccination record or serological evidence), including measles, mumps, rubella, and varicella. If immunity is lacking, consideration should be given to providing the appropriate number of MMR and varicella vaccinations (especially to those who are susceptible to varicella and plan to work with ill passengers or crew).[9,19] If a measles, mumps, rubella, or varicella case does occur onboard, the cruise line should promptly report the case to the public health authority at the next port of call and implement control measures, such as (1) isolation of cases; (2) identification and vaccination of susceptible contacts; (3) implementation of surveillance for cases among contacts and others aboard the ship; and (4) notification of passengers, particularly pregnant women, about their risk for exposure to rubella, measles, or varicella.[4,9,20]

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Declaration of Interests

The authors state they have no conflicts of interest to declare.

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This is a cruise ship in Victoria Harbour, Hong Kong at sunset. There are four articles in this issue related to maritime medicine. Three concern diseases (rubella, measles and varicella) that may be observed in cruise ship personnel, as well as passengers, although they are preventable through vaccination (see the original articles by Cramer et al., pp. 226–32, and by Mitruka et al., pp. 233–37, as well as the editorial by C. Schlaich, pp. 207–09 of this issue). The fourth article describes an outbreak of "imported" ciguatera fish poisoning on a cargo ship in the Port of Hamburg (see the original article by C. Schlaich, pp. 238–42 of this issue). *Photo credit: Eric Caumes (Setting: Victoria Harbour, Hong Kong)*