The Investigation of a Measles Outbreak, Kaohsiung, 2008

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Abstract

Measles is an acute and highly contagious viral disease. Until recently, it has been controlled, with less than 10 reported cases per year in Taiwan. At the end of December 2008, two suspected measles cases were reported from a hospital in Kaohsiung. A retrospective survey of these two cases was conducted. It found four waves of epidemics involving eight confirmed cases, including two nosocomial infections affecting four and two people respectively, as well as one community outbreak, in which one patient was infected. The survey tracked down the source of the pathogen and found the index case was imported from Shandong province of China. Subsequent outbreaks showed the increased risks of communicable disease outbreaks due to more frequent and convenient domestic and international travels and a much shorter travelling time. How to improve the awareness and knowledge of the general public about measles and to reduce the

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vulnerable groups should become the focus of intervention .Moreover, hospitals should alert their doctors to the risk of this disease and ensure the procedures of infection prevention in order to control and prevent further measles outbreaks.

Keywords: measles, nosocomial infection, community infection, imported case, MMR vaccine

Introduction

Measles is an acute and highly contagious virus systemic disease. It can be transmitted by airborne, droplet spreading or through direct contact with sufferers' nasal or throat discharge. Its incubation period is between seven and18 days but it normally takes 14 days to develop from exposure to the onset of exanthema. Typical clinical signs include fever, runny nose, and so called 3C clinical signs (coryza, cough, and conjunctivitis). Koplik spots can be observed after three to four days from onset of fever. After 1 to 2 days, exanthema would appear at the back of ears before spreading to the whole face and neck and continues its spread towards patient's body and four limbs. Exanthema would then disappear and to be replaced by desquamation and pigmentation. Other symptoms include anorexia, diarrhea (mainly in infants), and diffuse lymph node enlargement. 30% of the patients have one or more complications, most likely to happen to children under 5 years old and adults older than 20 years old. Complications include otitis media (7%, mainly in children), pneumonia (6%, caused by bacteria or virus re-infection and is the most common cause of death, accounted for 60% of the death), acute encephalitis (about 0.1%), subacute sclerosing panencephalitis and even death (0.01%). The

most common reason of death is pneumonia for children and acute encephalitis for adults [1-3].

Measles can infect more than 99% of people who do not have immunity against it, most of them children under five years old. Measles used to be regarded as an unavoidable disease for children and infants before the vaccine. When the Measles vaccination was not enforced in Taiwan, measles epidemic occurred almost every two years. Since 1978, most children have been receiving one dose of measles vaccine at 9 months and 15 months of age and the number of cases reported has been reduced dramatically. According to the statistical data, since 1990, the number of reported cases has been under 10 every year, with the exception of 1994 and 2002. Most of the cases (43.9%) had not vaccinated and 36% of the cases were imported. Imported cases mainly came from China, followed by the Philippines [4].

On 26 December 2008, the Centers for Disease Control (CDC), R.O.C. (Taiwan) received a report of a suspected Measles case from Hospital A in Kaohsiung City. The patient, Master Chen, was nine months old. On 31 December, the same hospital reported another suspected case to the CDC, Taiwan, this time a 40-year-old pediatric nurse working in the hospital. The health authority in charge immediately started its epidemic investigation in order to clarify the source of the infection and to prevent its further spread.

Epidemic investigation

The first stage - trace the source of infection

The index case, (case 1), Master Chen was 9 months old. He was

seen by a clinic on 8 Dec 2008 for bronchitis. Because his conditions did not improve, he was taken to Hospital A later the same day and was admitted into a double room in its pediatrics ward. He was discharged on the 17th. On 19 December, the patient began to develop symptoms of fever as high as 40℃, tiredness, lack of appetite, diarrhea, cough, sore throat, and nasal discharge. He sought medical advice on the 20th and again on the 22nd at Hospital A. On the 23rd, the patient started having urticaria, conjunctivitis, and Koplik spots. He went to Clinic B on the same day but as the symptoms did not improve so he visited Clinic B again on 25 December and was transferred into the Emergency Department in Hospital A. Based on his clinical signs, the hospital reported him as a measles case on 26 December and collected relevant samples to the Kunyang laboratory, CDC, Taiwan for tests. On 29 December, IgM positive and IgG negative results were obtained from the serum samples so he was officially confirmed as measles positive.

The second case reported (Case 2) was Miss Lee, a 40-year-old pediatric nurse working in Hospital A. During that month she was on night-shift and had looked after case 1. Fever as high as 39℃ was recorded, and cough was observed on 22 December. Exanthema appeared on her neck, body and four limbs on the 29th. The patient went to the Emergency Department of Hospital A on 28 December and again on the 30th because her conditions had not improved. She was diagnosed as a measles suspected case and the doctor reported and collected relevant samples to the Kunyang laboratory, CDC, Taiwan on the 31st. Her serum presented IgM and IgG positive results, thus she was confirmed as a positive case.

The Health Department in charge did a retrospective epidemic investigation on these two cases. Because these patients had not travelled overseas and claimed that they had no contact with any possible Measles cases outside the hospital, the possibility of nosocomial infection could not be ruled out. Health Department requested Hospital A to list those patients who stayed in its pediatric wards between 22 November and 22 December 2008, had MMR injection in less than two months or had not had MMR at all, and had displayed symptoms of fever and exanthema. In total, 14 patients were listed. First, any available samples collected during their stay such as serums or throat swabs were sent for further examination. Four samples were sent and among them, Case 3, was discovered. Master Tsai was two years and five month old and his sample was discovered with IgM and IgG positive. In order to understand the physical condition of the ward and other 13 patients listed with exanthema and fever, Health Department went to Hospital A to investigate the procedure of patients' hospitalization and their medical records. Sample collection was also arranged concurrently in order to eliminate the possibility of being infected by other pathogens.

Case 3 started displaying clinical signs such as fever, with a temperature as high as 40℃, conjunctivitis, cough, nasal discharge on 9 December. On the 13th, exanthema was observed and he was transferred from Clinic C to Hospital A and was placed in the bed next to Case 1 between the 13th and the 16th. It is possible that Case 1 and Case 2 were both infected by Case 3 after he moved in so the focus of investigation turned to Case 3. Based on this, Health Department listed possible contactors for tracing the source of pathogen and 577 people were on the

list. Further screening reduced the list to 481 people for tracing.

The second stage - trace the source of pathogen.

The Health Department in charge went to Case 3's house to do an epidemic investigation on 16 January 2009. The case went to a kindergarten during the day, and came back to his grandmother's house directly after school. At his grandmother's house he played with his cousin, Maser Chiu, a boy who was 2 years and 4 months old. Master Chiu was taken to Hospital B between the 16th and the 22nd of November 2008 because of bronchitis and sinusitis. Between the 2nd and the 8th of December, he was taken to Hospital B again because his fever had lasted for four days, and he had cough, nasal discharge, ulcer in his mouth, exanthema in his front abdomen, body and face. The epidemic investigation team collected Chiu's sample on the 17th of January 2009 and found the result was IgM and IgG positive. Chiu was listed as Case 4.

Case 4 was seen by Clinic D on 16 Nov 2008 because of fever, cough and nasal discharge. Because his clinical signs did not improve, he went to the Emergency Department of Hospital B. He was admitted into Ward G in its Pediatric Department. This was his first inpatient time and he was discharged from the hospital on the 22nd. On the 27th of November, he again displayed symptoms of nasal discharge and fever as high as 39.3℃. Exanthema appeared on 2 December. He was admitted into Hospital B for the second time and was discharged from the hospital on 8 December.

Investigation at this stage listed 210 people for tracing the source of infection and possible contact and reduced the list o 199 people after further selection.

The third stage - trace the source of outbreak

Based on the inpatient history of Case 4, he's most likely being infected during his first inpatient period. Thus, the source of the outbreak would be patients who stayed at the hospital at the same time, and had symptoms such as fever and exanthema. The patients fitted the above criteria were listed. The medical records of the 31 children listed were analyzed and six children with clinical signs of fever and exanthema during their inpatient time were selected. The epidemic investigation was conducted by on 21 January after the Health Bureau of Kaohsiung City and County contacted with them. The investigation found four patients who were considered as measles suspected cases. Samples from three patients were collected, (one patient's family refused to have his sample taken), and sent. All three presented serum positive. They were noted as Cases 5 to 7.

Case 5, Miss Chung, was 4 years and 5 months old. She started the symptom of fever, as high as 39℃, on 15 November 2008. Exanthema was observed on the 17th when she was taken to the Emergency Department in Hospital B. She was admitted into its pediatric ward G for treatment. This was her second time to be inpatient. She was discharged from the hospital on the 28th. During her stay, she played at the playground in the ward. Her medical record shows that she also stayed at Ward F at the same hospital between the 6th and the 9th, when she was hospitalized for the first time.

Case 6, Master Wu, was an 11 month old boy. He had fever as high as 39.6℃ on 14 November. Exanthema was observed on the 15th. He went to the Emergency Department of Hospital B on the 18th and was admitted into Ward G of its pediatric department, which was his second inpatient

time. He was discharged from the hospital on the 26th. He also played at the ward's playground during his stay. His medical record showed that he stayed at ward F of Hospital B after being transferred from its Emergency Department because of fever, which was his first inpatient time.

Case 7, Miss Wu, was a 10 month old girl. She had fever as high as 38.8℃. She went to the Emergency Department in Hospital B and was admitted into Ward G of its pediatrics department. This was her second inpatient time. Exanthema appeared on the 20th. She was discharged from hospital on the 23rd. She had visited the ward's playground. Her medical record showed that she stayed in Ward F in Hospital B between the 3rd and the 7th of December after being transferred from the Emergency Department, which was her first inpatient time.

The health department in charge contacted Hospital B on 3 Feb to request the non-serum samples of Cases 5-7 collected during their second inpatient time. However, only throat swab from Case 5 collected on 21 November 2008 was kept. It was transferred to the Kunyang laboratory, CDC, Taiwan for examination. It was confirmed as a measles positive case by the result of reverse-transcriptase polymerase chain reaction (RT-PCR).

Investigation at this stage found a list of 1,625 people, who might be the source of infection or have been in contact with patients. After careful consideration, 919 people were traced.

The fourth stage - trace the source of pathogen

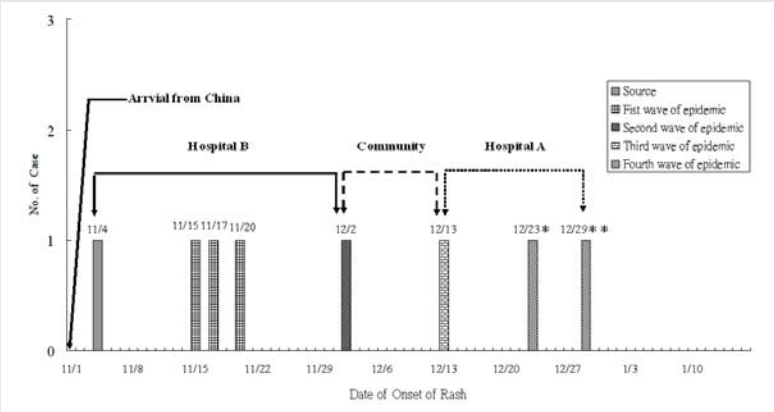
According to the inpatient and medical history of Case 5-7, their first inpatient period is the most possible latent period of the pathogen. Thus, the medical records of 30 people who visited the pediatrics ward F between the 2nd and the 9th of December 2008, had MMR vaccine less

than 2 months before inpatient or had not had MMR vaccine previously were reviewed. Eight suspected cases were selected because they had fever and exanthema during their inpatient period. These eight suspected cases were contacted by Kaohsiung City and County's Bureaus. Miss Tseng was one year and 8 months old. She came back from China on 1 November 2008 with her parents. Hospital B still kept her throat swab collected on 6 November, when she was an inpatient. The sample was sent to the Kunyang laboratory, CDC, Taiwan on 10 February 2009 for examination. She was confirmed as a measles positive case by RT-PCR on the 18th and was recorded as the Case 8. The health department also went to the other seven patients' houses to investigate. However, all of them could be ruled out. As a result, Miss Tseng was considered as the source of infection for Case 5 to 7.

The mother of Case 8 was a Chinese nationality. Cased 8 had lived in Heze city of SenTeng Province, China with her parents since March 2008. On 1 November, she flew back from SenTeng Province via Hong Kong by CI934, China Airlines and had her first dose of MMR vaccine on the same day. However, she developed fever, as high as 39.4℃, ulcer on mouth, cough, nasal discharge on 2 Nov. She had exanthema on neck and body and diarrhea on the 4th. Because of un-improved clinical signs, she went to Hospital B on the 5th and was admitted into Ward F of the Department of Pediatrics. She was discharged on the 13th, flew back to China on 28 November and had not come back to Taiwan. At this stage, the health department made a list of 202 people who had contacted with her. After careful consideration, 157 people were traced.

Discussion

This measles cluster event has four waves and eight patients were confirmed. Two nosocomial infections, where four and two people were infected respectively, and one community transmission, in which one person was infected. The epidemic curve of this cluster event was listed in Figure 1.



*Reported date : 26 December **Reported date : 31 December

Figure 1. The epidemic curve of the measles cluster event in Kaohsiung area in 2008

According to the World Health Organization (WHO) statistical data, although Chinese children get measles vaccine inoculation at 8 months old and at between 18 to 24 months old, and although between 2002 and 2007 (with the exception of 2005), the vaccine rate of both doses was higher than 90%, there were still 100 thousand of measles cases reported each year between 2005 and 2007 [5,6]. The epidemic reports in October 2008 from Shandong Province, where Case 8 lived, showed that the number of cases reported had increased, compared with the data presented at the

same period last year.

Heze city, where Case 8 lived, reported 15 measles cases, the 4th of all type B reported communicable diseases [7]. Further investigation found that Case 8 did not have direct contact with measles patients, nor had she been hospitalized for it. However, as her history of activities was unknown, it is possible that she had been infected by someone in the community back in China, and had only displayed clinical signs after she came back to Taiwan.

Among all eight measles confirmed cases, the genotype of samples from Case 1, 2, 5, and 8 were confirmed as the same H1 type. Out of these 8 cases, only Case 8 (the source of infection) had travelled overseas (Shandong Province, China) during the incubation period. The case's genotype is the same as the isolate identified in 2002 as originated from China as an imported case, and it also matches the information published by the WHO about the distribution of genotypes in China [8]. The relationships between these cases were listed on Table 1.

Because the cases of this cluster had visited hospitals or clinics, or had traveled by airplanes many times during the incubation and latent periods, while the source of pathogen is still unclear, it is necessary to list those people who had been in contact with them at different stages of their medical activities which involved eight clinics, two hospitals including their outpatients service, emergence service and three areas of pediatric wards, their communities, and the passengers who flew with them. A lot of people were affected. According to a seroepidemiological study, adults born in or after 1947, children who have had MMR vaccine within 2 months, and people who have not had MMR vaccine were considered the

highest risk groups. A total of 2,614 people had been listed and traced. After screening, the list cut down to 1,756 people. Telephone interviewing was used and if the phone was not answered, it would be followed up by home visit. 1,479 people were found so the tracing rate was 84.2%. Some people were missing because their telephone numbers were wrong, their phones were not answered, or they refused to cooperate.

Table 1. The information and examination results of cases in the measles cluster event, Kaohsing, 2008.

	Case1	Case2	Case3	Case4	Case5	Case6	Case7	Case8
Age groups (years old)	＜1	≧25	1~4	1~4	1~4	＜1	＜1	1~4
History of measles vaccination	None	Unknown	None	None	None	None	None	None
Serum	+	+	+	+	+	+	+	NA
Blood(ELISA)	+	+	NA	NA	NA	NA	NA	NA
Blood(pathogen isolation)	NA	+	NA	NA	NA	NA	NA	NA
Throat swab (pathogenisolation)	-	-	NA	NA	-	NA	NA	-
Throat swab (RT-PCR)	+	+	NA	NA	+	NA	NA	+
Urine (pathogen isolation)	-	+	NA	NA	NA	NA	NA	NA
Urine (RT-PCR)	+	+	NA	NA	NA	NA	NA	NA
Genotypes	H1	H1	NA	NA	H1	NA	NA	H1

Notation: NA: no sample; +: positive; -: negative; ELISA: enzyme-linked absorbent assay

Conclusion

The best way to prevent measles is to get vaccinated. [10]. In the USA, there used to be approximately 500 thousand reported cases each year until the government's introduction of measles vaccination 1963. [11]. In 2000 the USA government announced that it has reached the goal of eradicating measles [12]. Despite its effort, recently there have been a few

measles events within its communities and medical centers caused by imported cases [13-15].

Measles vaccine was introduced into Taiwan in 1967. Since 1978, this vaccine has been included in the routine schedule for children and was replaced by MMR vaccine in 1992 [4]. However, although the introduction of vaccine has controlled measles outbreaks, it has not been able to eradicate this disease. As global travelling has become more and more frequent and convenient, many adults who were born in the above periods have become invisible groups vulnerable to measles outbreaks or become the source of infections.

The measles outbreaks in 2002 and the fact that Case 2 in this investigation was born in 1969 seem to be supporting this argument [8]. According to the annual reports published by CDC, the average vaccination rate of the first dose of MMR in previous years has been 95-96%. Although it varied in different areas, the vaccination rate also reached approximately 95% in Kaohsiung area. Parker et al. mentioned that a higher rate of MMR inoculation represents a lower possibility of transmission in communities [13] so in this event, there was only one case of the community transmission.

However, after a certain period of time, the unvaccinated population would become susceptible. So, as soon as this cluster started, we urged children under 6 years old in key areas of the cases' activities to have MMR vaccine inoculation. The campaign was expected to expand to the whole Kaohsiung area, with a goal to reach the 95% of MMR vaccine inoculation rate in the key areas before the Chinese Lunar New Year.

The statistical data showed that measles mainly affect unvaccinated children under four years old [16]. This data matches the age distribution

of current study (Table 1). General public often miss vaccination because of false contraindications such as mild fever, cough and cold, family reasons or negative experience of vaccination in the past [17]. Cases 3 to 5 in this event missed vaccination for the same reasons. Some people even hold the view that “one’s health will be better after measles” and prefer to acquire a natural immunity against measles. Some people may have missed the vaccination by accident and do not seek to complete the vaccination afterwards. Most people when they developed false contraindications after vaccination will delay the next vaccination consequently missed the MMR vaccination. Health departments should routinely check their record, and ensure those who have missed MMR vaccination to be vaccinated in time in order to avoid outbreaks caused by a high susceptible population.

While studying the background of this measles cluster event, it is clear that the pubic do not have enough understanding about measles. Other than an increased public education effort to ensure the general public get MMR vaccination on time, it is also necessary to educate those people who intend to travel to or stay in measles epidemic areas to have MMR vaccination prior to their travel [11,18,19]. Case 2’s working environment, (in the department of pediatrics), is categorized as a high risk environment with a high risk population. Researchers around the world have suggested that MMR vaccine to be included in the routine vaccines for medical workers [11]. In the “Conference for treatment and prevention for measles cluster events” on 17 January, CDC, Taiwan also suggested that new staff and current workers in hospitals, especially those who work in departments of obstetrics and gynecology, pediatrics and emergency departments should all get MMR vaccine if they have not had antibodies against measles or

have not been vaccinated of MMR.

While tracing the source of pathogen in this event, the retrospective survey found that doctors' lack of awareness of measles would delay the monitoring and reporting of measles outbreaks. In the past 10 years measles cases have reduced dramatically, many medical workers are unfamiliar with the clinical signs of measles. Despite all eight patients had displayed typical clinical signs of measles, (as listed in Table 1) [20], they were all considered as exanthemas caused by other viruses. As a result, this epidemic was only discovered and reported at the fourth wave of infection. It tells us that we must increase doctors' alertness of measles. Moreover, two nosocomial infections happened during this event. It shows that hospitals have failed to follow the basic infection control practices and would need to fill this gap in the future.

Few measles cases have been seen in recent years, it is especially rare to have a measles event this size in the past 10 years. After this event, health departments should discuss how to increase the current success rate of 84.2% for tracing the source of infection and its contacts. Lessons must be learned from this experience for dealing with similar epidemic events in the future.

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