

Measles outbreaks among health workers in a university hospital admission ward in Northeastern Thailand in 2019: reflections on the occupational health management system

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Objectives This study examined a measles outbreak among health workers in a university hospital admission ward and details of the existing occupational health management system.

Methods Secondary data was obtained from two sources: 1) from the Occupational Health and Safety Office outbreak investigation report a post-exposure immunity evaluation which is completed after a measles, mumps, or rubella outbreak and 2) from the medical records of the individual cases. In addition, the Occupational Health and Safety Office guidelines were reviewed and a descriptive epidemiological investigation was conducted.

Results A total of 75 health workers in the university hospital admissions ward who were potentially exposed were included in the study, of whom three were diagnosable as measles based on a positive immunoglobulin M (IgM) test. The three health workers who were identified as confirmed cases were nursing assistants; two worked in the admissions ward 4A, and one worked in the cardiac care unit. We found evidence that a propagated source caused the outbreak. The occupational health management system in the hospital at that time had only exposure and post-exposure protocols, but no pre-exposure protocol.

Conclusion None of the health workers who were diagnosable as measles had been examined for measles immunity during their pre-placement health examination. The occupational health management system should revise the policy for ensuring the immunity to measles of health workers before allowing them to begin work and conducting a respirator fit test before using an N95 respirator. *Chiang Mai Medical Journal* 2021;60(2):165-74. doi 10.12982/CMUMEDJ.2021.15

Keywords: measles, health workers, occupational health management system, outbreak investigation, hospital setting

Introduction

Measles is grouped with diseases that produce fever with rash and is caused by a virus in the paramyxovirus family (1,2). It can be transmitted by breathing in contaminated air or by the virus having direct contact with eyes, nose, or mouth. It is highly contagious and leads to infection in approximately 90% of non-immune cases (1,3). The manifestation of symptoms can be categorized into 3 stages: 1) the incubation period (7-14 days, average 10-12 days), 2) the fever phase, and 3) the

rash phase (4). Measles can lead to complications in all age groups, but especially in children under 5 and adults over 20 (5). Between 2010 and 2011, the number of measles cases in Southeast Asia (SEA) increased from 52,529 to 65,161 (6). In 2015, the incidence was 17 per one million population (7). In 2018, the World Health Organization (WHO) reported that SEA had the second largest number of cases of measles in the world (n=82,384). Between February 2018 and January 2019, Thailand ranked number one out of the top

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ten affected countries for measles cases (8).

According to the Occupational Safety and Health Administration (OSHA), immunization is the best procedure for preventing occupational exposure to measles (9). Measles can be prevented with the MMR vaccine which is very effective and safe. Two doses of MMR vaccine are 97% effective against measles, while a single dose is 93% effective (10). The WHO's global vaccine action plan suggests the SEA region should focus on eliminating measles and controlling rubella in 2020 (11). In 2018, the WHO estimated the first-dose (MCV1) and second-dose (MCV2) coverage of measles-containing-vaccine was 67-99% and 52-90%, respectively. In Thailand that year, MCV1 coverage was 96%, while MCV2 coverage was 87% (12,13).

Hospitals represent a workplace that has many, primarily biological, hazards. Up to 4% of cases of measles are transmitted in medical settings. Health workers (HWs) in admission wards are at risk of contracting the disease, which can lead to understaffing, increased workloads, and stress as well as increased costs due to additional overtime pay (14,15). HWs have a significantly higher incidence of acute health conditions than non-health workers (16). The incidence rate of measles for physicians is 2.5 per 100,000 individuals per year and for nurses is 1.2/100,000 (17,18). Between 2007 and 2009, a total of 64 HWs were infected with measles in secondary and tertiary care hospitals in Thailand (14), suggesting the existence of gaps in infection control (18).

According to OSHA and the Centers for Disease Control and Prevention (CDC), occupational health management systems (OHMS), both infection control and occupational health service (OHS), play an essential role in the prevention and control of measles in hospitals (19-21). According to published guidelines, five steps go into making an effective OHMS: generate policy, plan, implement the plan, evaluate, and review and improve the system (16,22). A good OHMS can provide beneficial outcomes such reduced illnesses and infections, reduced compensation costs, and reduced absence from work (23). To

reduce the risks associated with measles infection in HWs, the OHMS must develop comprehensive OHS and infection control that includes: 1) providing vaccination, 2) implementing pre-placement health examinations, 3) early identification of cases, 4) prompt isolation of suspected and confirmed cases, 5) use of proper hand hygiene, and 6) correct use of appropriate personal protective equipment (20,24). MMR vaccine is recommended for HWs who have had direct contact with patients. There are, however, other clearly identifiable high-risk groups of HWs, e.g., personnel working in the obstetrics and pediatrics departments, which are the only groups for which measles immunity is verified in practice (25,26).

A university hospital admission ward in northeastern Thailand discovered a patient with suspected measles had been admitted to ward 4A (medicine ward) with fever on February 1, 2019 at 10:58 a.m. Within a few days it was discovered that a number of HWs in two admission wards had measles-like symptoms.

That incident of the spread of measles among HWs reflects the status of OHMS in the hospital at that time. However, the OHMS during the measles outbreak among HWs has not yet been studied. To help fill this gap, we conducted a study of the measles outbreak in the university admission wards using data from HWs who had contacted measles.

Objectives

The present study aimed to examine a measles outbreak in HWs in a university hospital admissions ward in northeastern Thailand and to describe the existing occupational health management system at that time.

Methods

This epidemiological investigation used descriptive research. All data were recorded anonymized to protect the privacy of the patients. The institutional review board certified the current study (IRB00001189), and the Khon Kaen University Research Ethics Committee reviewed and approved the study (HE621200). The study pop-

ulation was comprised of 75 HWs at a university hospital in northeast Thailand who had had contact with a measles index case. Cases were defined as either suspected, probable, or confirmed. Suspected cases were those in which the patient had a fever $> 38^{\circ}\text{C}$ and a maculopapular rash in combination with at least one of the following symptoms: conjunctivitis, mucous membrane inflammation, or Koplik spots. Probable cases were suspected cases in which the patient had a history of contact with a confirmed measles case. Confirmed cases were those in which the patient had a positive measles immunoglobulin M serology test.

We obtained the outbreak investigation report and extracted secondary data from two sources: 1) the Occupational Health and Safety Office form (second version) which is completed after a measles, mumps, or rubella post-exposure immunity evaluation, and 2) medical records of cases including signs, symptoms, and laboratory data. Secondary data from the two sources included age, sex, job title, workplace, history of measles infection, and history of measles immunity. It also included the date of onset of illness, symptoms, history of contact with suspected measles patients, i.e., duration of contact and activities undertaken, laboratory data (e.g., measles IgM), duration of OPD/IPD treatment, complications, days absent from work, and date of activation of the post-exposure surveillance system. A review of the Occupational Health and Safety Office guidelines for managing HWs who contact measles cases was performed. These guidelines included the management system process of the HW during and after exposure.

Data were analyzed by measuring central tendencies and line listing and were compared with data for the previous 5 years during the same period (data from the Communicable Disease Control Unit). These data described the OHMS infection prevention process (policy, plan, implement the plan, evaluate, and review and improve the system) as it relates to measles outbreaks. The existing “policy, plan, implement the plan, and review and improve systems” policies and pro-

cess prior to the measles outbreak and the actual management actions during the recent measles outbreak were described.

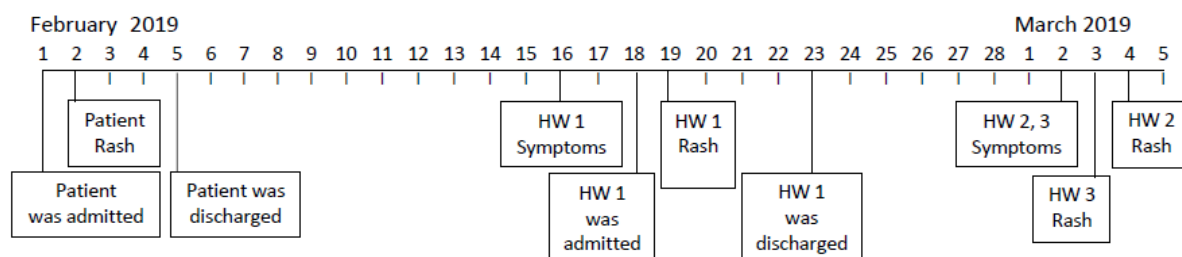
Results

The university hospital admission ward in the northeast Thailand hospital identified the first non-health worker measles patient on February 1, 2019. The patient, a 32-year-old male suspected of having measles, was admitted to the hospital's admissions ward 4A in an isolation room. He received acetaminophen, oral rehydration solution, and 0.9% normal saline solution intravenously. The same day, his measles was confirmed by positive serologic test (immunoglobulin M antibody). This was the index case. The patient developed a rash on February 2 and was discharged on February 5. The transmission period for this patient was from January 29 to February 6. He experienced no complications during admission or discharge. After identifying the index case, the Occupational Health and Safety and Communicable Disease Control Unit investigated all 75 HWs exposed to the index case. The average age of the HWs was 35.3 years (11 males and 64 females; 1 doctor, 49 nurses, 14 nursing assistants, 8 nurse aides, and 3 cleaning staff). HWs had either a history of previous measles infection with no evidence of positive measles IgM or had received a single dose of MMR vaccine. None had developed signs or symptoms of measles. Among the individuals who had had contact with the index case, there were a total of three confirmed cases and no suspected or probable cases (Table 1). The attack rate was 0.04. The total number of measles cases in HWs in the study hospital during the same period each year from 2014 to 2018 was 0, 2, 1, 0, and 0.

The first infected health worker (HW1) was a 28-year-old male nursing assistant working in admission ward 4A where the index case was admitted. His duties included checking the patient's vital signs, e.g., fever and blood pressure, three times per 8-hour shift. HW1 worked on the index case every day from February 1-5. He spent a total of approximately 90 minutes in contact with the

Table 1. Contacted cases history of previous measles infection and receipt of MMR vaccine of HWs

History		Confirmed measles	Probable measles	Suspected measles	No signs or symptoms of measles
History of previous measles infection	Yes	0	0	0	5
	No	3	0	0	67
History of receiving one dose of MMR vaccine	Yes	0	0	0	10
	No	3	0	0	62

**Figure 1.** Timetable of actions taken in the three measles cases

patient in the isolation room over six shifts. On February 16, he began to experience fever and nasal discharge. He put on a surgical mask before going to the hospital's emergency room to seek outpatient treatment. He received acetaminophen and chlorpheniramine and was advised to go home and to observe his symptoms. On February 18, he returned to the emergency room and was admitted to an isolation room in the hospital's admissions ward AE3. On February 19, he developed a cough, a rash, Koplik spots, and diarrhea while hospitalized. On February 20, he was confirmed as having measles (IgM positive). HW1 was discharged February 23 and convalesced at home until February 27 (Figure 1).

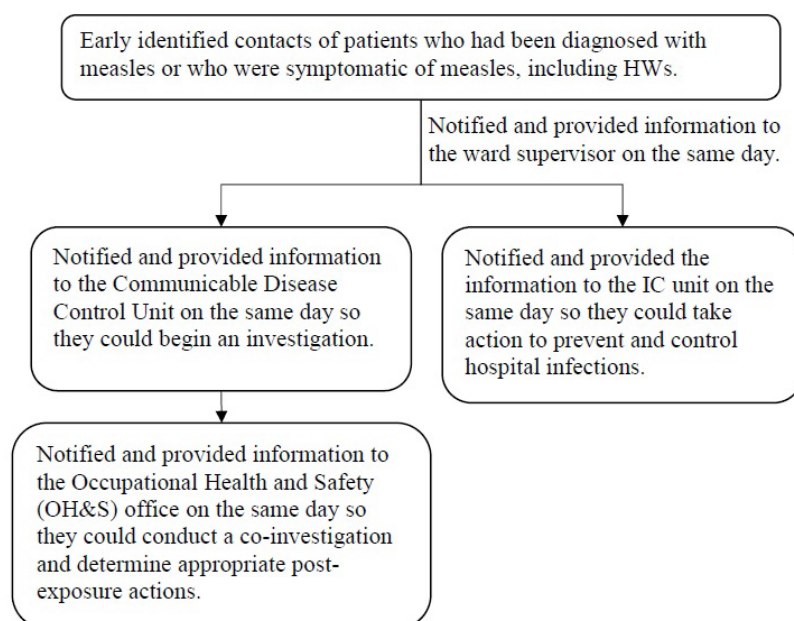
The second infected health worker (HW2) was a 29-year-old male nursing assistant who also worked in admissions ward 4A where the index case had been admitted. His duties, like HW1, were to check the patient's vital signs twice per 8-hour shift. He worked on the index case from February 3-5. HW2 spent approximately 30 minutes in contact with the patient in the isolation room over a total of five shifts. HW2 came into contact with HW1 at their dormitory with neither individual wearing an N95 mask on February 16. HW2 developed a fever on March

2. On March 4, he developed a rash, cough, and diarrhea. He went to the hospital's general practice room wearing a surgical mask to seek outpatient treatment. He received acetaminophen, bromhexine, and oral rehydration solution. He was advised to rest at home and was given a follow-up appointment for March 8 to receive his measles IgM results. HW2 convalesced at home until March 8 on which date he was confirmed as having measles (IgM positive).

The third infected health worker (HW3), a 32-year-old male nursing assistant on duty at the Cardiac Care Unit (CCU) looked after HW1 at his dormitory. HW3 spoke with HW1 once for about 5 minutes on February 17. HW3 stated he did not touch HW1. HW3 developed a fever on March 2. On March 3, he developed a rash and cough. He went to the hospital's general practice room wearing a surgical mask to seek outpatient treatment. HW3 received acetaminophen, and dextromethorphan, was advised to rest at home and was given a follow-up appointment for March 8 to receive his measles IgM results. HW3 convalesced at home until March 8 on which date he was confirmed as having measles (IgM positive) (Table 2).

Table 2. Timeline of measles cases

Case	Date of last exposure	Date of symptom onset	Rash onset	Transmission period	Period spent away from work
HW1	5 Feb. 2019	16 Feb. 2019	19 Feb. 2019	15-23 Feb. 2019	18-27 Feb. 2019
HW2	16 Feb. 2019	2 Mar. 2019	4 Mar. 2019	28 Feb. – 8 Mar. 2019	5-8 Mar. 2019
HW3	17 Feb. 2019	2 Mar. 2019	3 Mar. 2019	27 Feb. – 7 Mar. 2019	4-8 Mar. 2019

**Figure 2.** Structure of the post-exposure action process of an occupational health management system

The OHMS had a standing policy and protocol governing exposure and post-exposure action processes. When a HWs was exposed to a communicable disease such as measles, there were three departments to prevent the spread of the infection. Interdepartmental communication and cooperation is described in Figure 2. Following that standing policy, infections were to be reported to the Occupational Health and Safety (OH&S) Office and the IC unit on the day an infection was identified. In the present case, two reports were made the same day and one was made the following day (Table 3).

The OH&S team investigates and manages post-exposure cases using a secondary version of the post-exposure evaluation form. Occupational Health and Safety Office guidelines for managing exposed HWs include procedures to be followed during exposure (hand-washing, use of an N95

respirator) and post-exposure (vaccination of non-immune HWs, exclusion from work). In the present case, none of the HWs who lacked evidence of measles immunity received the MMR vaccine and none were excluded from work after exposure (Table 4). The occupational health and infection control measures show that none of the HWs had undergone verification of immunity before starting employment. Two of 67 and two of 29 HWs of the HWs who did not use an N95

Table 3. Activation date of the post-exposure surveillance system

Case	Date of report to the Occupational Health and Safety Office	Date of report to the Infection Control unit (IC unit)
HW1	21 Feb. 2019	21 Feb. 2019
HW2	4 Mar. 2019	5 Mar. 2019
HW3	3 Mar. 2019	3 Mar. 2019

Table 4. Occupational health management system for prevention and control of a measles outbreak

Process	Actual practice
Policy development	2015 Occupational Health, Safety and Environment structure development only
Planning	Goal: HWs exposed measles cases do not get the disease Plan workflow for infection control in HWs which includes the budget and process action during or post-exposure.
Implementation	Implementation during and post-exposure process were no post-exposure vaccine or exclude HWs from work.
Evaluation	No MMR vaccine was provided due to a shortage of vaccines. HWs not excluded from work due to a small number of HWs working in the admission ward.
Review and improve	Continual improvement; meeting and revise the plan, developed document more than 1 version.

respirator and who did not wash their hands after every contact with a patient developed measles. Only one of 8 HWs who used an N95 respirator and one of 46 HWs who washed their hands after every contact with a patient developed measles. Of the three confirmed cases among the HWs, only one case both used proper respirator and washed their hands after every contact with a patient as a standard precaution (Table 5).

Discussion

A total of 75 HWs were exposed to the measles case. The 75 contacts can be categorized into 4 groups: there were 72 HWs with no signs or symptoms of measles, 0 suspected cases, 0 probable cases, and 3 confirmed cases. This outbreak of measles in three HWs likely spread within Ward 4A from the index patient. This was classified as an outbreak because the number of cases of measles in HWs in 2019 was greater than the 5-year median (0.0) and greater than the average number plus double the standard deviation (2.4) over the previous 5 years. According to the CDC (27),

Table 5. Occupational health and infection control measures

Cases	Occupational health hazard control measures								Infection control measures		Contact with
	Administrative control						Personal protective equipment		Hand washing		
	Evidence of immunity against measles						N95 respirator used				
	Verify documentation of adequate vaccination		Verify laboratory evidence of immunity		Verify laboratory confirmation of measles						
	Actual practice	Standards recommendation	Actual practice	Standards recommendation	Actual practice	Standards recommendation	Actual practice	Standards recommendation	Actual practice	Standards recommendation	
HW1	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Index case
HW2	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	Index case
HW3	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	HW1
							No	Yes	No	Yes	HW1

the incubation period for measles is 7-14 days, so HW2 could have been infected by HW1 rather than by the patient. HW3 was likely infected by HW1, while HW1 was infected by the patient. Transmission was person-to-person rather than from a common source. It was a propagated outbreak. HW1 was probably infected via direct contact rather than breathing in contaminated air as he used an N95 respirator. On the other hand, HW3 most likely got the measles virus through breathing in contaminated air rather than direct contact as he did not use an N95 respirator and did not touch HW1. Thus the spread of measles from the index patient could have been prevented or controlled by proper hand-washing and use of an N95 respirator. Spread of the measles virus from one HW to another can be prevented or controlled by having a comprehensive OHMS to help ensure personnel safety. A comprehensive OHMS can not only prevent the spread of measles to patients but also among HWs.

OHMS play an important role in the prevention and control of measles in hospitals (19-21). According to the Hospital and Healthcare Standards (4th edition) of the Healthcare Accreditation Institute (Public Organization) (HA4 Part I-5.1 - Workforce Environment), vaccination, evaluation, and caring for HWs exposed to infectious disease can help ensure healthy HWs. Part II-4 (Infection Prevention and Control) includes disease reporting procedures and standard precautions for preventing and controlling infectious diseases (28,29). The goals of I-5.1 and II-4 are personnel safety and patient safety, respectively. In the current research, the OHMS of this hospital at the time only partially followed HA4, i.e., the hospital had only exposure and post-exposure protocols but no pre-exposure protocol, e.g., measles immunization programs. Early reporting is essential for disease control (30-32). Although there was early reporting in the case of HW1, measles was transmitted to HW2 and HW3, suggesting incomplete compliance with exposure and post-exposure protocols (viz., evaluating evidence of immunity against measles, management of exposed HWs who lack immunity,

proper hand-washing, and use of an N95 respirator). In terms of evidence of immunity against measles, one of the following is needed: (a) written documentation of adequate vaccination, (b) laboratory evidence of immunity, (c) laboratory confirmation of measles, or (d) evidence of birth before 1957 (33). Thais born before 1957 cannot be assumed to have evidence of immunity because Thailand's national policy to provide a single dose of measles vaccine to children 9 months of age began in 1984 and the policy to provide two doses (at 9 months of age and again in the seventh grade) began in 1996 (34). It can thus be assumed that Thais born in the country who were over 35 years of age in 2019 are unlikely to have been vaccinated, and that those between age 23 and 35 probably received a single dose, while that those under 23 years probably received two doses. Based on that assumption, there should have been a total of 45 HWs who had had at least 1 dose of vaccine. In fact, the present study found only 10 HWs (22.2%) had a history of having been vaccinated. None of the 10 vaccinated individuals contracted measles. According to CDC recommendations, HWs without evidence of immunity who are exposed to measles should get their first dose of the MMR vaccine within 72 hours of exposure and should isolate themselves from work from day 5 after their first exposure to day 21 following their last exposure (33). The current study found this recommendation was not followed, which may have led to the spread of measles in the hospital. There are a small number of HWs working in admissions ward 4A and the CCU, so it is probably impossible for them to isolate themselves after exposure to measles. Necessary CDC and OSHA processes include (a) a policy to keep HA4 on II-4 (29), (b) using an N95 respirator while in direct contact with measles patients, and (c) washing hands after contact (9, 33). Seal-checking and fit testing of N95 respirators must be accomplished before their use (35). In our hospital at the time of this study a process for training HWs in the proper use of N95s (fit testing) had not been implemented. The HWs who used an N95 respirator and yet still developed measles

may have been wearing the mask improperly. This finding is consistent with a previous study by Winter et al. Which reported that a single size of face mask does not fit all and that only 16% of HWs passed an N95 respirator fit test (36). A previous study by the IC unit found that while 92.8% of HWs practiced hand-washing, only 81.2% did so properly. The number of people who washed their hands during the current outbreak (61.3 %) was less than that and may have been one of the causes of the outbreak.

The current study has some limitations. The investigation team did not identify the HWs who treated the three confirmed measles cases in HWs. Those individuals could not be traced because of a lack of information in the secondary data. A study which includes the HWs who contacted the three confirmed measles cases during treatment in OPD may be able to identify management processes that could help prevent the spread of measles in the future. An additional limitation was the lack of data on assessment of proper wear of N95 respirators; future studies which include this data may provide information about the correlation between proper wear of N95 respirators and measles infection.

Conclusions

All three cases of measles infection among HWs that were confirmed by a positive serologic test for the immunoglobulin M antibody after contact with an infected individual had no evidence of measles immunity. This outbreak showed that the OHMS at the hospital studied was incomplete. Further improvement in OHMS are needed to strengthen safety procedures, e.g., ensuring health workers' immunity and fit testing N95 respirators before use. Hospital departments should encourage these processes to ensure personnel safety and hospital administrators should support enforcement of those policies.

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Conflicts of interest

The authors report no potential conflicts of interest.

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วัตถุประสงค์ เพื่อศึกษาการระบาดโรคหัดในบุคลากรสุขภาพในหอผู้ป่วยในโรงพยาบาลมหาวิทยาลัยแห่งหนึ่ง และเพื่อศึกษาระบบการจัดการด้านอาชีวอนามัย

วิธีการ งานวิจัยนี้เป็นการศึกษาแบบวิเคราะห์ข้อมูลย้อนหลังที่ได้มาจาก 2 แหล่งข้อมูล ได้แก่ 1) ข้อมูลการสำรวจภูมิหลังเกิดการสัมผัสหัด หัดเยอรมัน และคางทูมของสำนักงานอาชีวอนามัยและความปลอดภัยและ 2) เวชระเบียนของผู้ป่วย นอกจากนี้ยังศึกษาแนวทางปฏิบัติของสำนักงานอาชีวอนามัยและความปลอดภัย โดยงานวิจัยนี้ใช้การสอบสวนทางระบาดวิทยาเชิงพรรณนา

ผลการศึกษา บุคลากรสุขภาพที่สัมผัสกับผู้ป่วยโรคหัดมีทั้งสิ้น 75 คน ในจำนวนทั้งหมดนี้พบบุคลากรสุขภาพ 3 คนที่ป่วยเป็นโรคหัดที่ได้รับการยืนยันจากภูมิต้านทานชนิดเอ็มต่อเชื้อหัดให้ผลบวก บุคลากรสุขภาพ 2 คนเป็นผู้ช่วยพยาบาลที่หอผู้ป่วยใน 4 ก และ 1 คน เป็นผู้ช่วยพยาบาลที่หอผู้ป่วยในวิกฤตหัวใจ จากการสอบสวนพบว่าเป็นการระบาดแบบแหล่งโรคแพร่กระจาย จากการระบาดพบว่าระบบการจัดการด้านอาชีวอนามัย ณ ขณะนั้นมีการจัดการเพียงช่วงขณะมีการสัมผัสและภายหลังการสัมผัส แต่ไม่พบการจัดการก่อนการสัมผัส

สรุป บุคลากรสุขภาพที่ได้รับการยืนยันโรคหัดไม่พบประวัติการตรวจหาภูมิต้านทานต่อโรคหัดก่อนเข้าทำงาน ระบบการจัดการด้านอาชีวอนามัยควรมีการทบทวนนโยบายการสร้างภูมิคุ้มกันโรคหัดในบุคลากรสุขภาพในขณะที่ตรวจประเมินความพร้อมก่อนเข้าทำงานและทดสอบความกระชับของหน้ากาก N95 ก่อนที่จะนำไปใช้ **เชียงใหม่เวชสาร 2564;60(2): 165-74. doi 10.0.12982/CMUMEDJ.2021.15**

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