Outbreak, Surveillance, Investigation & Response (OSIR) Journal
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Associated Factors of Influenza B Infection from a Staff-introduced Outbreak in a Prison, Buriram Province, Thailand, September–November 2023

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Received: 31 May 2024; Revised: 21 Nov 2024; Accepted: 3 Dec 2024
https://doi.org/10.59096/osir.v17i4.269503

Abstract

On 17 Oct 2023, the Office of Disease Prevention and Control Region 9 Nakhon Ratchasima was notified of 570 influenza-like illness cases in a prison in Buriram Province, Thailand. An investigation was performed to confirm the outbreak and diagnosis, identify sources and risks, and provide recommendations. National surveillance database and prison records were reviewed, and an active case-finding in the prison targeted individuals with fever, cough, sore throat, runny nose, or myalgia between 20 Sep 2023 and 18 Nov 2023. Suspected cases were individuals who developed fever with at least one other symptom. Confirmed cases were suspected cases with a positive result based on the reverse transcription polymerase chain reaction technique. A total of 678 cases (attack rate 39.6%) were identified, including 28 confirmed influenza B cases. Three were admitted and there were no intubations or deaths. Vaccine coverage in the prison was 33.1%. Observations revealed overcrowding, poor ventilation, inadequate sick-person management, and a lack of hygiene facilities. A case-control study considering suspected and confirmed cases as true cases and symptom-free inmates as true non-cases identified exposure to close-range sneezing (odds ratio 2.03, 95% confidence interval 1.23–3.36) and sporadic face mask-wearing (odds ratio 1.67, 95% confidence interval 1.07–2.63) as significant risk factors after adjusting for other factors. Interventions included screening, early quarantine, event cancelation, and enhanced hygiene practices. The outbreak subsided within three weeks. We recommended the use of prison records to develop a surveillance system, improving sick staff management, increasing vaccine coverage, and reducing overcrowding.

Keywords: influenza, outbreak, prison, Buriram Province, Thailand

Introduction

Influenza is a contagious respiratory illness caused by influenza viruses. It can cause mild to severe illness with common symptoms including fever, cough, sore throat, runny nose, and myalgia. The disease mainly spreads through droplets. It has an incubation period of 1–4 days and a contagious period from one day before to seven days after the onset.[1] The disease is usually self-limited and often requires no treatment; however, an anti-influenza drug such as oseltamivir can shorten the illness duration and minimize viral shedding.[2–4] Isolation and quarantine play a significant role in containing influenza pandemics.[5]

The influenza virus is a common cause of outbreaks in prisons.[6] Between 1 Jan 2022 and 7 Nov 2023, Thailand recorded 16 prison outbreaks, 11 of which were acute respiratory infections, including five influenza A and one unspecified influenza outbreak.[7] Influenza

vaccination is crucial for preventing influenza outbreaks. The reported effectiveness of influenza vaccines varies by around 40%–60%.[8] Previous studies indicated that herd immunity can be achieved at a vaccine coverage of 50%.[9] Risk factors identified from previous investigations into influenza outbreaks include overcrowded conditions, proximity to influenza cases, and sharing utensils with others.[10–13]

On 17 Oct 2023, the Office of Disease Prevention and Control Region 9 Nakhon Ratchasima (ODPC 9) was notified of an outbreak in a prison in Nang Rong District, Buriram Province in the northeastern region of Thailand, involving 570 inmates with symptoms of influenza-like illness (ILI). ODPC 9 and Buriram Provincial Public Health Office conducted a joint field investigation on 18–19 Oct 2023 to confirm the outbreak and diagnoses, describe the epidemiological characteristics, find possible sources, determine factors associated with influenza infection, and provide control measures to prevent future outbreaks for both inmates and staff.

Methods

To confirm the outbreak, we reviewed influenza case numbers in Nang Rong District, Buriram Province, from the national surveillance databases (2018–2023) and compared them to the 5-year median. Mean ILI cases were calculated from the nurse station's patient records.

Descriptive Study

Active case finding was conducted among all inmates and prison staff. An ILI case was defined as any person with at least one symptom, including fever (body temperature ≥37.8 °C or history of fever), cough, sore throat, runny nose, or myalgia, between 20 Sep 2023 and 18 Nov 2023. A suspected case was an ILI case who had a fever and at least one other symptom. Suspected cases who tested positive by reverse transcription polymerase chain reaction (RT-PCR) were categorized as confirmed cases. ILI case findings after 18 October (the investigation period), were performed by prison staff through daily screening until no new cases were identified for 14 days.

We collected nasopharyngeal swabs from suspected cases with symptom onset within three days for COVID-19 screening using an antigen test kit and for influenza testing via RT-PCR at the Bamrasnaradura Infectious Disease Institute or the Department of Medical Science, Ministry of Public Health. Influenza-positive specimens with a cycle threshold (CT) value <25 underwent whole genome sequencing to identify a subtype.

We conducted a walkthrough survey of dormitories, toilets, shops, cooking areas, dining areas, and quarantine and isolation rooms in the prison. Direct observations were conducted on dining, drinking, and personal hygiene behaviors, and on how ILI control measures were implemented. Prison staff were interviewed about their work activities and personal hygiene practices. In-depth interviews were conducted with staff who worked at the nurse's station, focusing on the processes and protocols of ILI surveillance, screening, quarantine, and isolation systems.

Analytical Study

A case-control study was conducted to identify factors associated with influenza infection among inmates in Zone 1, which was the zone that had the highest attack rate. We used a structured questionnaire to collect self-reported data on demographic characteristics such as age, gender, weight and height, underlying diseases, symptoms, risk behaviors, and vaccine history (influenza and COVID-19). Body mass index (BMI) was calculated from self-reported weight and height by weight (kg) per height (m^2) and categorized as underweight (BMI <18.5 kg/m^2), normal (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2), and obese (BMI ≥30.0 kg/m^2). We defined suspected and confirmed cases as true cases and symptom-free inmates (no ILI symptoms) as true non-cases (controls).

Statistical Analysis

We described continuous data using medians with interquartile range (IQR) and frequencies and proportions for categorical data. Univariable and multivariable logistic regression models were used to determine factors associated with influenza infection. Factors with a *p*-value <0.1, or factors that were previously associated with influenza infection from other studies, namely vaccination, were included in the multivariable logistic regression models. Odds ratios (OR) with 95% confidence intervals (CI) were calculated using R version 4.3.1. We used the "tidyverse" package for data management and the "lmtest" package for model diagnostic testing.

Ethics

Ethical clearance was waived as this investigation was conducted as part of a response to a disease outbreak. All results were aggregated without any individual-traceable data.

Results

National surveillance data (2018–2023) showed influenza cases in Nang Rong District exceeded the 5-year median starting on October 2022 and peaking in September 2023 (district: 360 versus 6; provincial: 3,630 versus 248 cases). Nurse station records reported 1,344 ILI cases from January–September 2023, averaging 149 cases per month (approximately five per day).

Descriptive Study

This prison was for inmates who had been sentenced to less than 20 years, with occupational training before release. In September 2023, it housed 1,713 individuals consisting of 88 staff and 1,625 inmates (1,489 male and 136 female) with four male zones (Zones 1, 2, and 3, and an elderly zone) and one female zone.

Following the active case finding and monitoring until the outbreak waned, 678 ILI cases were identified (4 staff, 674 inmates). The overall attack rate of cases was 39.6% (678/1,713). The attack rate among staff was 4.5% (4/88) and among inmates was 41.5% (674/1,625) (Table 1).

All staff were vaccinated in 2023 but only 33.1% (190/574) of interviewed inmates reported being vaccinated in the past 12 months (84 of 658 inmates interviewed were excluded from vaccine coverage calculation due to uncertainty about their vaccination status and timing).

Table 1. Distribution of ILI cases in staff and inmates by gender and zone in a prison, Nang Rong District, Buriram Province, Thailand, 20 Sep 2023 to 18 Nov 2023

	Number of ILI cases	Total	Attack rate (%)
Staff	4	88	4.5
Inmates			
Male			
Zone 1	457	710	64.4
Zone 2	115	316	36.4
Zone 3	40	298	13.7
Zone 4 (elderly)	27	84	32.1
Female	35	136	25.7
Total	678	1,713	39.6

Among the 658 interviewed inmates in Zone 1, 454 cases were identified. The median age of the cases was 30.5 years (IQR 14 years). Of these, 54 (11.9%) had underlying diseases, with hypertension, asthma, diabetes mellitus, and allergic rhinitis being the four most common conditions (Table 2).

Common symptoms of the cases were runny nose (69.1%), cough (63.4%), sore throat (60.4%), fever (50.7%), myalgia (48.5%), and headache (45.9%). Less common symptoms were fatigue, chill, dyspnea, conjunctivitis, diarrhea, and vomiting (17.4%, 16.4%, 8.2%, 4.6%, 4.6%, and 2.6%, respectively). Three cases developed viral pneumonia and there were no deaths or intubations.

Table 2. Characteristics of interviewed prison inmates in Zone 1 in a prison, Nang Rong District, Buriram Province, Thailand, 20 Sep 2023 to 18 Nov 2023 (n=658)

Characteristics	Inmates	ILI cases	Percentage of ILI cases among inmates
Interviewed	**658**	**454**	**69.0**
Median age (IQR) in years	**31.0 (13.0)**	**30.5 (13.0)**	-
Median BMI (IQR) in kg/m²	**22.9 (4.24)**	**22.9 (4.25)**	-
Underlying disease (%)	**74 (11.2)**	**54 (11.9)**	**73.0**
Hypertension (%)	14 (2.1)	8 (1.8)	57.1
Asthma (%)	10 (1.5)	6 (1.3)	60.0
Diabetes Mellitus (%)	6 (0.9)	4 (0.9)	66.7
Allergic Rhinitis (%)	4 (0.6)	4 (0.9)	100.0
Dyslipidemia (%)	2 (0.3)	2 (0.4)	100.0
Psychosis (%)	2 (0.3)	2 (0.4)	100.0
HIV infection (%)	2 (0.3)	1 (0.2)	50.0
Self-reported vaccine history from interview	**574**	**390**	**67.9**
Less than 12 months ago (%)	190 (33.1)	126 (32.3)	66.3
More than 12 months ago (%)	93 (16.2)	60 (15.4)	64.5
Never (%)	291 (50.7)	204 (52.3)	70.1

ILI: influenza-like illness. BMI: body mass index. IQR: interquartile range.

Between 21 Sep and 5 Oct 2023, four staff members experienced fever. All sick staff members were absent for one day and returned to work and wore masks while they still had flu-like symptoms. Two of them had symptom onset within four days before the first inmate cluster onset (5 Oct 2023). On 2 Oct 2023, a staff member took sick leave and returned to work the next day. This staff member had to work in Zone 1 because each staff member had to rotate to other zones every day due to a lack of personnel. There was a staff common room that facilitated staff interactions. There was no protocol for sick staff returning to work. Three days later, the first cluster occurred in Zone 1, leading to a subsequent increase in cases. On 12 Oct 2023, a group event involving inmates from all zones took place for one hour. Following this event, the number of cases rose and peaked on 16 Oct 2023. Staff initiated screening, quarantine, and isolation measures. After that, the number of cases began to decline, while the number of cases in Zones 2 and 3, and the female zone showed an increasing trend (Figure 1).

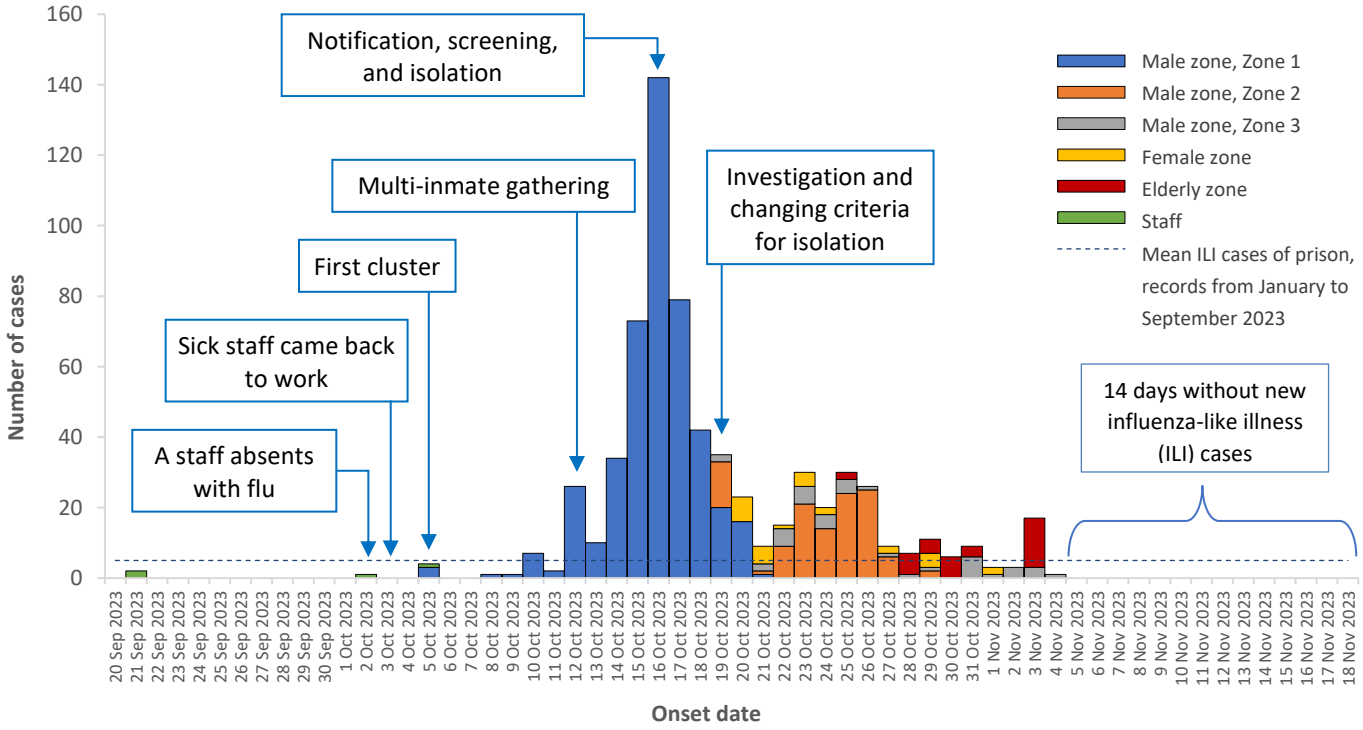

Figure 1. Epidemic curve of ILI cases in a prison, Nang Rong District, Buriram Province, Thailand, 20 Sep 2023 to 18 Nov 2023 (n=678)

Of the interviewed inmates in Zone 1, 29 nasopharyngeal swabs were collected from suspected cases, of which 28 (96.5%) tested positive for the influenza B virus. Whole genome sequencing revealed the presence of the B/Austria/1359417/2021 (B/Victoria lineage)-like virus strain with the V1A.3a.2 lineage in all three samples eligible for testing. Additionally, COVID-19 tests at the same time as the RT-PCR sample collection using antigen test kits returned negative results for all 29 cases.

The average space of an inmate in the prison was 1.2 m^2. Inmates shared personal items such as water glasses, utensils, and clothes with others. Although there were three hand wash basins, no soap was provided, and alcohol sanitizing gel was unavailable due to prison restrictions. Face masks provided by the prison were insufficient for all inmates. A shop within the prison allowed inmates to purchase items using fingerprint scans for payment, but there was no alcohol sanitizing gel or handwashing basins provided for inmates to use either before or after scanning. Inmates from Zone 3 could interact with those in Zone 1 while cooking in the canteen. No visitors were allowed inside the prison, but inmates could access on-site visits through a clear glass window and communicate using a phone. Visitors could only send money to inmates through the prison credit system.

ILI Surveillance, Screening, Quarantine, and Isolation Systems

Since 2022, the prison has implemented quarantine regulations for new or returning inmates including a 10-day quarantine for newcomers and a 5-day quarantine for returning inmates before entering a specific zone. Quarantined inmates were housed in a single building with multiple rooms where air ventilation was inadequate. Quarantine periods began when a room reached full capacity or had no new arrivals for three days. If an inmate in a room

exhibited ILI symptoms, he or she would be isolated into a negative pressure room equipped with air-draining vents and the quarantine period of the rest would be reset.

In the nurse's station, the number of ILI cases was recorded and reported monthly to the prison director. While there were no specific outbreak detection criteria, staff would initiate fever and blood-oxygen desaturation screenings twice a day if they suspected an outbreak. Inmates showing symptoms would be sent to the nurse station or isolation room based on severity for a 7-day observation period. Initial treatment was provided by nurses with referrals to a hospital if conditions worsened. Vaccination records in the nurse's station showed discrepancies with less than 10% matching interview results due to record loss during inmate transfers.

After the investigation, cases were isolated for seven days after the onset of their symptoms. All gathering events were canceled and inter-zone contact was prohibited. Emphasis was placed on proper personal hygiene practices, including wearing masks, practicing social distancing, avoiding sharing personal items, and regular handwashing. Prison staff screened those with at least one ILI symptom twice daily for early detection and isolation until no new cases were reported for 14 days (completed on 18 Nov 2023). The ODPC 9 provided 4,000 face masks and 250 tablets of oseltamivir to the prison for severe or high-risk cases. However, control measures were not fully implemented due to the prohibition of alcohol gel in the prison for security concerns, and not all high-risk cases could be treated with oseltamivir due to national shortage.

Analytical Study

Interviews were conducted with 658 inmates in Zone 1 (92.7% of 710 inmates), of which 214 (32.5%) were true cases and 204 (31.0%) were true non-cases. The median (IQR) weight, height, and BMI among all inmates were 65 (12) kg, 1.70 (0.09) m, and 22.9 (4.2) kg/m^2, respectively. Significant risk behaviors from the univariable analysis included sporadic wearing of face masks, sleeping near sick inmates less than two meters), contact with a case in the past seven days, exposure to close-range sneezing less than two meters), and sharing utensils or clothes with others (p <0.05) (Table 3).

After multivariable analysis, sporadic wearing of face masks and exposure to close-range sneezing remained significant risk factors (adjusted OR 2.03, 95% CI 1.23–3.36) (Table 4). Diagnostic testing on this model showed no multi-collinearity.

Table 3. Result of univariable analysis showing factors associated with influenza infection among inmates in Zone 1 in a prison, Nang Rong District, Buriram Province, Thailand, 20 Sep 2023 to 18 Nov 2023 (n=418)

Factor	Cases with exposure/ total cases	Controls with exposure/ total controls	Crude odds ratio	95% confidence interval	*P*-value
Individual factors					
Influenza vaccine history (n=361)					
Non-vaccinated (reference group)					
Within 3 months	13/100	20/107	0.65	0.30–1.39	0.264
3–6 months ago	21/108	20/107	1.05	0.53–2.07	0.888
More than 6 months ago	56/143	57/144	0.98	0.61–1.58	0.942
Body mass index (n=363)					
Normal (reference group)					
Underweight	24/164	14/153	1.70	0.85–3.43	0.133
Overweight	15/155	20/159	0.74	0.37–1.51	0.414
Obese	4/144	7/146	0.57	0.16–1.98	0.541
Having underlying disease (n=418)	27/214	20/204	1.33	0.72–2.45	0.362
Behavioral factors					
Sporadic wearing of face mask (n=415)	138/212	105/203	1.74	1.17–2.58	0.005
Sleeping near sick inmates (<2 meters) (n=417)	137/213	103/204	1.77	1.19–2.62	0.004
Contact with a case in past 7 days (n=413)	122/212	96/201	1.48	1.01–2.19	0.046
No handwashing before eating, drinking, or touching their own face (n=415)	101/212	83/203	1.32	0.89–1.94	0.166
Exposed to close-range sneezing (<2 meters) (n=415)	105/213	60/202	2.30	1.53–3.45	<0.001
Sharing glasses and utensils with others (n=418)	88/214	62/204	1.60	1.07–2.40	0.022
Sharing clothes with others (n=418)	19/214	8/204	2.39	1.02–5.58	0.039
Receiving visitors (n=414)	62/211	69/203	0.81	0.53–1.22	0.314

Table 4. Factors associated with influenza infection among inmates in Zone 1 in a prison, Nang Rong District, Buriram Province, Thailand, 20 Sep 2023 to 18 Nov 2023

Factors	Adjusted odds ratio (95% confidence interval)
Sporadic wearing of face mask	1.67 (1.07–2.63)
Sleeping near sick inmates (<2 meters)	0.91 (0.49–1.65)
Contact with a case in past 7 days	1.29 (0.73–2.28)
Exposed to close-range sneezing (<2 meters)	2.03 (1.23–3.36)
Sharing glasses and utensils with others	0.96 (0.58–1.57)
Sharing clothes with others	1.68 (0.67–4.54)
Influenza vaccine history (ref=non-vaccinated)	
Within 3 months	0.69 (0.31–1.51)
3–6 months ago	1.16 (0.56–2.40)
More than 6 months ago	0.97 (0.59–1.61)

Discussion

A likely source of this influenza B outbreak was symptomatic staff who returned to work seven days after onset. This outbreak exhibited a higher attack rate (39.6%) compared to a previous influenza B outbreak in a nearby prison in Chaiyaphum Province in June 2023 (21.3%).[12] Risk factors identified included sporadic wearing of face masks and exposure to close-range sneezing.

Previous studies identified staff, new inmates, and visitors as common routes of disease introduction into prisons.[14] The absence of protocols for symptomatic staff members returning to work may have contributed to the current outbreak. Typically, sick staff members were absent for only a few days and returned to work during the contagious period of influenza, until seven days after onset.[1] Because of staff shortages, a 7-day absence was not feasible. Therefore, practical measures such as wearing masks while working at the prison and conducting daily symptom screenings for staff might have been more effective.

The average space for an inmate in this prison was 1.2 m^2. However, the recommended minimum space for Thai correctional facilities is 1.6 m^2 and the minimum space from the European Convention for the Prevention of Torture and Inhuman or Degrading Treatment or Punishment (CPT) standard is 4 m^2, both of which indicated the overcrowded condition of the prison.[15,16] There was no soap provided at the wash basin and no alcohol sanitizing gel for inmates to adequately wash their hands. These factors may have contributed to the spread of influenza within the prison.

Our analysis identified sporadic wearing of face masks and exposure to close-range sneezing as significant risk factors. These factors are consistent with findings from several other prison outbreak investigations.[10–13] Exposure to close-range sneezing is attributable to the overcrowded conditions of the prison. These factors are major obstacles to controlling respiratory infection outbreaks in prisons. Focusing on disease-introducing prevention and vaccination programs could be more effective measures.[8,9,14]

The vaccine coverage of inmates was 33.1%, which is lower than the 50% herd immunity threshold for influenza, and therefore its protective impact was limited.[9] However, many studies have shown the effectiveness of influenza vaccines in reducing hospitalization, intensive care unit admission, and death.[17–19] Vaccination of inmates, especially in vulnerable groups such as the elderly or those with underlying disease, is suggested.

The identified strain, B/Austria/1359417/2021 (B/Victoria lineage)-like virus was included in the 2023 World Health Organization recommended trivalent vaccine for the Southern Hemisphere, including Thailand.[20] The recommendation indicated that this influenza strain was circulating in Thailand and that herd immunity from the recommended vaccine could prevent this outbreak.

Control measures were initiated four days after the first peak of the outbreak, which had been delayed due to the absence of an ILI surveillance system. However, following the implementation of screening and isolation measures, case numbers steadily declined, indicating that early detection through screening of individuals with at least one ILI symptom and comprehensive isolation for seven days were effective in the prison context.

Limitations

Characteristics of ILI cases among the prison staff were unavailable. Since we only received numbers and the onset of ILI cases from the prison's staff screening between 19 Oct and 18 Nov 2023, other characteristics could only be described among all 454 ILI cases that

the investigation team interviewed. We only had access to Zone 1 in the prison since no cases were reported from other zones prior to the investigation. This could have caused selection bias. The study design was case-control due to the ambiguous source of the population, despite interviewing >90% of inmates in Zone 1. The heights and weights of inmates were self-reported since anthropometric measurement tools were not available. Only 10% of interviewed inmates could have their vaccine history matched to the prison vaccine records due to the high inmate exchange rate. Finally, some inmates could not remember their last influenza vaccine date, thus recall bias may have occurred.

Conclusion

We identified an influenza B outbreak in a prison with an attack rate of 39.6%. There were no severe cases and no deaths. The viral strain identified by whole genome sequencing was the B/Austria/1359417/2021 (B/Victoria lineage)-like virus. Onset of the first cluster of cases occurred on 5 October, the peak on 16 October, and the last case on 4 Nov 2023. A possible source of the outbreak was staff returning to their work duties while still infectious. Sporadic wearing of face masks and exposure to close-range sneezing were identified as significant risk factors. Overcrowding, inadequate sick-person management, and lack of hygiene facilities were observed. Strict adherence to quarantine and isolation protocols and screening for any ILI symptoms to facilitate early detection and isolation were crucial for controlling this outbreak.

Recommendations

To prevent future influenza outbreaks in prison, prison staff should increase the availability of handwashing facilities with soap in common contact areas (shop, canteen, and nurse's station). Strict adherence to screening, quarantine, and isolation protocols is essential. Staff at the nurse's station should develop guidelines for sick staff who return to work. These could include requirements to stay at home during the contagious period, or if long leave during contagious periods is not possible, then wearing masks and handwashing, plus daily pre-work screening to consider ILI symptoms beyond fever would be helpful. Based on patient records in the nurse's station, information should be utilized to develop an ILI surveillance system in the prison. The occurrence of more than five cases per day should be considered a potential outbreak indicator. This threshold is adaptable by nurse station staff based on the results of this newly established surveillance system. Policymakers should focus on increasing vaccine coverage and reducing overcrowded conditions in the long term to improve the overall health of staff and inmates and prevent future outbreaks.

Acknowledgements

We would like to thank the prison staff, the provincial public health office, district hospital staff, Bamrasnaradura Infectious Disease Institute, the Department of Medical Sciences, and the joint investigation team of ODPC 9.

Funding

We did not receive any funds from private individuals to conduct this investigation.

Conflicts of Interests

No conflict of interest.

Suggested Citation

Rongdech W, Sujinpram S, Yueayai K, Sanmai S, Chongkratok P, Chumpook N, et al. Associated factors of influenza B infection from a staff-introduced outbreak in a prison, Buriram Province, Thailand, September–November 2023. OSIR. 2024 Dec;17(4):206–13. doi:10.59096/osir.v17i4.269503.

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