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Editorial

Eating Raw Food is Risky

Angela Song-En Huang, Chief Editor

I must have been about 7 years old when I was introduced to lettuce. Growing up in Taiwan, lettuce was not a common vegetable when I was young. I remember being instructed to eat lettuce raw. The concept of eating a leafy vegetable without cooking was unthinkable. Later on, having lived in the United States, I learned to eat many other vegetables raw. Nowadays, when I chomp on raw cabbage, raw spinach, or raw broccoli, some of my Taiwanese friends look at me in horror, reminding me that such vegetables should be cooked.

Eating raw vegetables is a common practice even though it is associated with risk of disease. Despite *Escherichia coli* O157:H7 outbreaks associated with spinach, despite Salmonella outbreaks associated with romaine lettuce, salads made using raw vegetables remain a stable part of our meals. To control outbreaks associated with raw vegetables, announcements go out urging people to rid of the contaminated foods, and recall the products, if feasible. Ultimately, the goal is to keep foods safe to eat, even raw.

Eating raw protein, such as beef, fish, or pork, is not practiced as widely as eating salads, because it is considered unsafe in different cultures. However, there are many dishes around the world made with raw meat. Steak tartare is often made with raw minced beef. The best-known raw fish dish is sashimi. Eating raw pork is less common, however, versions of raw pork dishes can be found in both Asia and Europe.

Even though eating raw meat of any kind pose health risks, real or not, raw pork seems to have the worst reputation. The association between *Streptococcus suis* infections and eating raw pork has been demonstrated numerous times by studies conducted in Thailand and Vietnam. The most common clinical manifestation of *Streptococcus suis* infection is meningitis. Even if patients recover from the acute episode, some people are left with permanent deafness or other sequelae. It is a serious disease that could be prevented by cooking pork thoroughly.

However, this message is lost in some raw pork eating regions, so we continue to see outbreaks caused by eating raw pork, as shown in the article "Outbreak of Human *Streptococcus suis* cases in Chum Phuang District, Nakhon Ratchasima Province, Thailand, 2018".

Culture, tradition, and experience all play important roles in our food practices. What one culture deems a delicacy food, another may consider the food risky. Foods eaten may also change over time. With the spread of food cultures around the world, I have adapted to eating salads, and seen sashimi gain wide acceptance far beyond Japan. I might one day find eating raw pork becoming more common. Therefore, as has been done for vegetables, in addition to health education about the risks of eating raw pork, meat processing practices must also minimize contamination of pork to prevent outbreaks.

Behavioral and Environmental Factors Associated with an Influenza Outbreak in a Prison of Thailand

Suphanat Wongsanuphat[1]*, Thanachol Wonghirundecha[1], Peewara Boonwisat[1], Kawinna Kerdsalung[1], Kritchavat Ploddi[2], Itsarate Sawangjaeng[2], Kanchana Kongcha[3], Supaporn Midtrapanon[3], Pimthai Ananthawan[4], Thitipong Yingyong[1], Panithee Thammawijaya[1]

1 Division of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand

2 Office of Disease Prevention and Control 7, Khon Kaen Province, Department of Disease Control, Ministry of Public Health, Thailand

3 Roi Et Provincial Public Health Office, Ministry of Public Health, Thailand

4 Ministry of Justice, Thailand

*Corresponding author, email address: at_acoustic@hotmail.com

Abstract

Influenza is a highly contagious disease. Due to a high number of reported cases with influenza-like illnesses in a prison, a joint investigation by the Department of Disease Control and local public health teams was conducted to confirm the reports and implement control measures. Suspected influenza cases were defined as a prison inmate or an officer who developed fever with coughing and/or a sore throat. A confirmed case was a suspected case that had a nasopharyngeal swab testing positive for influenza by RT-PCR. The prison environment and health practices were observed. A retrospective cohort study was conducted to determine factors associated with influenza diagnosis. The overall attack rate was 12.7% (326/346) and 16 out of 19 tested positive for influenza A (H1N1) pandemic 2009. Vaccine effectiveness among prisoners who had history of influenza vaccination more than or equal to 2 weeks and less than 2 weeks prior to the outbreak was 25.9% and 13.8%, respectively. Sleeping near a case (adjusted odds ratio (OR) = 3.60, 95% confidence interval (CI) = 1.62-8.00), working near cases (adjusted OR = 3.39, 95% CI = 1.59-7.22), and sharing cigarettes with other cases (adjusted OR = 2.46, 95% CI = 1.15-4.56) were significant risk factors. A strong correlation between attack rate in each area and inmate density was found (r = 0.68, *p*-value = 0.025). Rapid transmission and high attack rates were probably attributed to overcrowded conditions. Expanded provision of vaccination in prisons should be implemented.

Keywords: influenza A (H1N1) 2009, influenza-like illness, vaccine effectiveness, prison, inmate

Introduction

Seasonal influenza represents a year-round disease burden. It causes illnesses that range in severity and sometimes leads to hospitalization and death.[1] In 2018, thirty-seven influenza outbreaks were reported to the Department of Disease Control (DDC), Ministry of Public Health. Of those, prisons are the most common place.[2] Among outbreaks reported from prisons, influenza ranks the highest in magnitude.[2] In addition, morbidity and case fatality rates of influenza in prisons are also higher than in the community.[2]

On 1 Aug 2018, the DDC was notified of an outbreak in a Thai prison in the northeastern region involving nearly 200 prisoners with influenza symptoms. The DDC, Office of Diseases Prevention and Control 7, and the Provincial Health Office conducted an investigation during 7 to 9 Aug 2018. The objectives of the investigation were to confirm the outbreak, to describe its epidemiological characteristics, to determine the risk factors associated with influenza sickness and to control the outbreak.

Methods

We undertook a descriptive study of all

prisoners and staff in the prison to identify anyone with influenza-like illnesses which included suspected and confirmed cases. A suspected case of influenza was defined as a person with a current or history of fever (>38 degrees Celsius) with coughing or sore throat during 16 Jul to 8 Aug 2018. A confirmed case was a suspected case who had a throat or nasopharyngeal swab testing positive for influenza by reverse transcription polymerase chain reaction (RT-PCR) at Bamrasnaradura Infectious Diseases Institute. Severe complications including pneumonia and respiratory failure were identified.

A semi-structured questionnaire was used to collect data. We collected data on demographic characteristics (age and sex), signs and symptoms, risk behaviors including inadequate washing of hands, sharing glasses, cigarettes, spoons and towels, contact with suspected cases and protective factors including current year vaccination history.

Either nasopharyngeal or pharyngeal swabs were collected among 10% (20/200) of initial notified cases who had an onset of illness less than four days prior to the interview or who had severe complications. The specimens were sent to identify the type and subtype of any influenza viruses detected by RT-PCR at Bamrasnaradura Infectious Diseases Institute.

For the environmental study, we inspected physical structures focusing on the numbers of buildings, work zones, dormitories and dining zones. We calculated the density of inmates using the size of a utility space divide by the number of prisoners in those areas. We calculated the correlation between attack rate in each area and inmate density using Pearson's method. Among activities, observations were focused on dining, drinking behavior and personal hygiene. We interviewed staff and directly observed activities by walk-through survey to assess infection control measures for acute respiratory diseases according to guidelines developed by the World Health Organization.[5]

We conducted a retrospective cohort study in order to identify factors associated with influenza-like illnesses (both suspected and confirmed cases). Our cohort was defined as male prisoners who had been in the study prison during 16 Jul to 8 Aug 2018. A case was defined as a suspected or confirmed case in the descriptive study. The prevalence of influenza was used to determine adequate sample size by reviewing the medical literature.[6] The proportion of people working and not working near a case and among influenza cases were 0.76 and 0.63, respectively.[6] From calculation, the required sample size was 422 which provided 80% power and 95% confidence. We performed stratified random sampling by dormitories for sample selection.

Statistical Analysis

For descriptive statistics, continuous data were presented using median with inter-quartile range (IQR). Categorical data were presented using frequency and proportion. The basic reproductive number (R_0) was calculated based on the attack rate using the R-program and the R_0 package, in order to estimate the transmission rate of influenza.[7,8] The effective reproduction number (R) was calculated based on the epidemic curve and the serial interval from previous literature with the Wallinga and Teunis method using the EpiEstim package, in order to estimate the Cohort appropriation of control measure.[9,10]

For analytic statistics, bivariable and multivariable logistic regression models were used to determine factors associated with being a case. In bivariable analyses, a risk ratio and its 95% confidence interval (95% CI) were calculated. All variables having *p*-value less than 0.1 in bivariable analyses were put into the initial multivariable model. We reported adjusted odds ratios (OR), 95% confidence intervals (95% CI), and population attributable fraction (PAF). Vaccine effectiveness was calculated by comparing the number of prisoners with an influenza-like illness (both suspected and confirmed cases) who received at least one dose of influenza vaccine more than or equal to 2 weeks and less than 2 weeks prior to the outbreak occurring. Both groups were compared to prisoners who had no vaccination in the study year.

Ethics

Ethical clearance was omitted as this investigation was conducted as part of a response to a disease outbreak.

Results

Setting and General Description

The study setting is a provincial prison located in Mueang District, Roi Et Province. Although the penitentiary system was designed to accommodate 1,000 inmates as deemed by the Ministry of Justice, the actual prison population was 2,728 prisoners. In Aug 2018, the mean incarceration rate was 18.4 prisoners/day (range 5-84) and the mean release rate was 14.2 prisoners/day (range 6-34). The total weekly turnover rate was 8.7% (244.5/2,800).[11]

Outbreak Description

From the active case finding, we found 346 influenza cases. Of these, 326 (94.3%) were male and all were prisoners. Nineteen nasopharyngeal swabs were collected from prisoners and 16 (84.2%) tested positive for influenza A (H1N1) 2009. The overall attack rate was 12.7%. The zone-specific attack rates ranged from 0% to 42.8% (Table 1, 2). The median (IQR) age of influenza cases was 31 years (24-38 years). According to the Thai Clinical Practice Guideline for Influenza, 19 prisoners were classified as high risk due to their asthma, diabetes mellitus, tuberculosis and HIV status.[12] However, there were no hospitalizations, no serious complications and no deaths.

Table 1. Number of influenza cases by dormitory between 16 Jul and 8 Aug 2018

Characteristics	Total population screened	Number of cases	Attack rate (%)
Male	2458	326	13.26
Dorm Male 1	841	119	14.15
Dorm Male 2	853	115	13.48
Dorm male 3	764	86	11.26
Female	270	20	7.41
Total	2728	346	12.68

During 19 to 26 Jul 2018, about one week prior to the current outbreak, a prison parade competition was held and included prisoners from other Northeast prisons including a reported recent influenza A (H1N1) outbreak prison. After the parade competition, influenza outbreaks occurred in two other prisons.

Table 2. Number of influenza cases by physical structures between 16 Jul and 8 Aug 2018

Characteristics	Total population screened	Number of cases	Attack rate (%)
Occupational training zone (5 zones)	473	77	16.28
Central zone	1750	246	14.06
Education zone	38	1	2.63
Supporting zone	22	3	13.64
Kitchen zone	304	13	4.28
First aid ward zone	15	0	0.00
TB isolation room	14	6	42.86

Figure 1 shows the epidemic curve, which indicated a propagated source outbreak. The first case was a 23-year-old male with no underlying disease. He joined the parade competition and had close contact with other prisoners who had symptoms of cough and nasal congestion. In addition, we found 34 Influenza cases among prisoners (36.9%) who joined parade competition. The first cluster of female cases appeared on 5 Aug 2018. They joined a justice video conference and sat in close proximity to male cases on 2 Aug.

Reproductive Number

The basic reproductive number (R_0) was 1.08 (95% CI = 1.06-1.14). The effective reproductive number (R) during the early period of the outbreak was 5.41 and decreased rapidly afterward. On investigation day, it decreased to below 1 (Figure 2).

Environmental Study

For physical structures, there were 13 zones in this prison: five occupational training zones, a central zone, an education zone, a supporting zone, a kitchen area, a dining zone, a first aid room, tuberculosis (TB) isolation room and 3 dormitories.
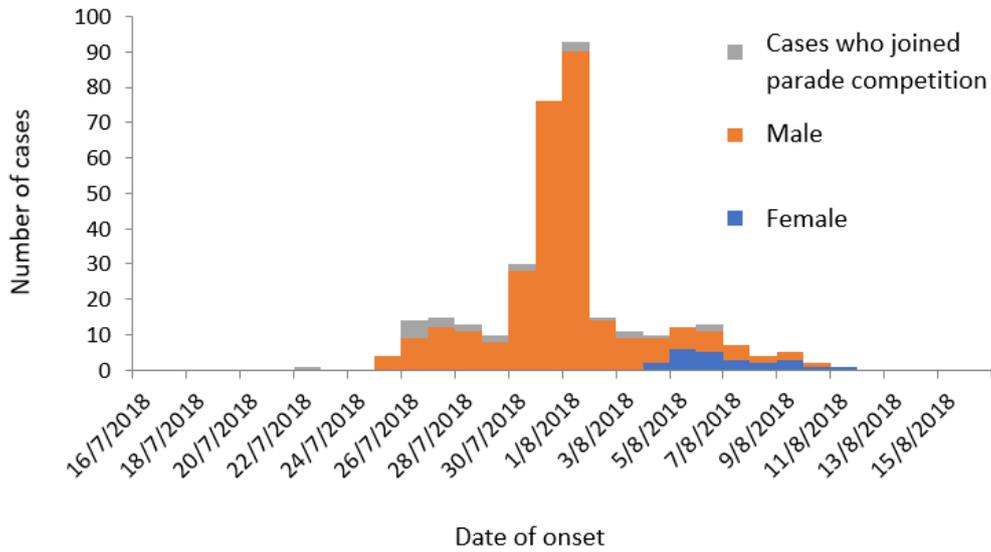
Figure 1. Number of influenza cases in the prison by date of onset between 16 Jul and 8 Aug 2018
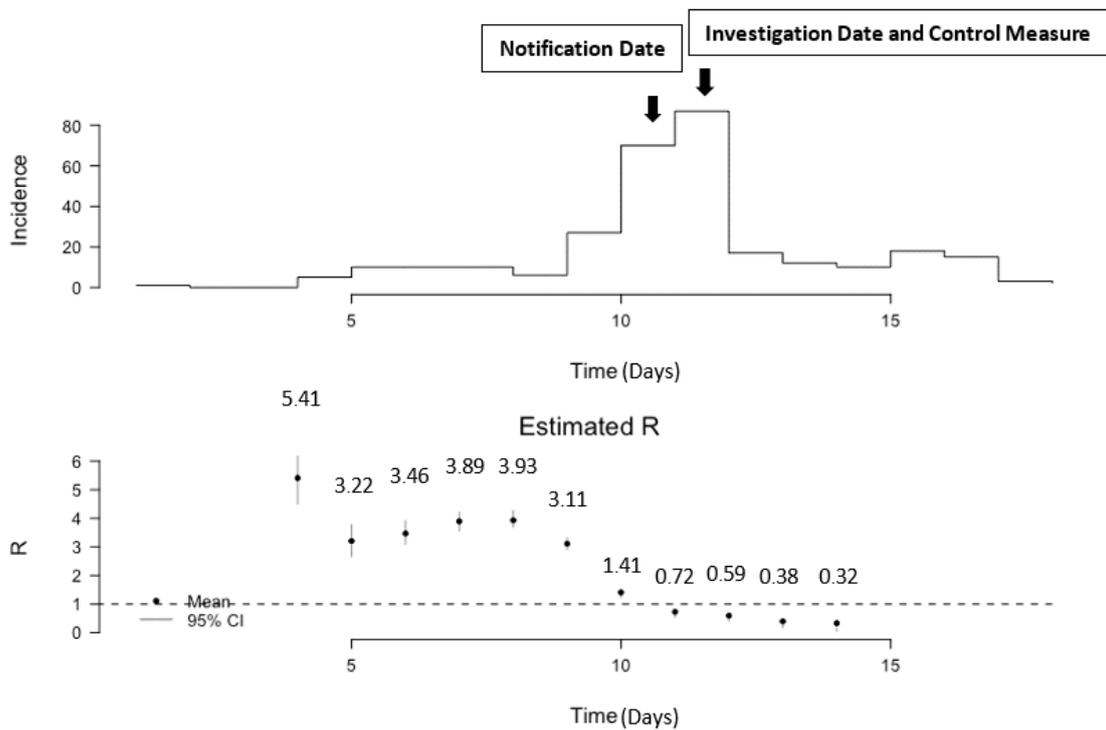
Figure 2. The effective reproductive number of influenza outbreak in the prison between 16 Jul and 8 Aug 2018

Occupational training zones are for work practice prisoners. The number of prisoners per training room ranges from 30-220 (0.76–7.33 m²/prisoner). The central zone is used to house general prisoners around 1,500-1,600 prisoners (0.50 m²/prisoner). The education zone, which includes a library, accommodates a maximum of 40 prisoners (4.00 m²/prisoner). The supporting zone is occupied by 20 prisoners (1.60 m²/prisoner). The dining area can accommodate up to 450 prisoners comfortably, however, due to

overcrowding, approximately 800 prisoners dine together during mealtimes (0.40 m²/prisoner). The first aid room can occupy for around 30 patients, and some of its area is separated for TB isolation room. There are 3 dormitories with 6 rooms in each and there are around 200 prisoners/room (0.90 m²/prisoner).

In overcrowded areas (density <1.1 m²/person, Department of Corrections), the median attack rate was 33.2% while for non-crowded areas
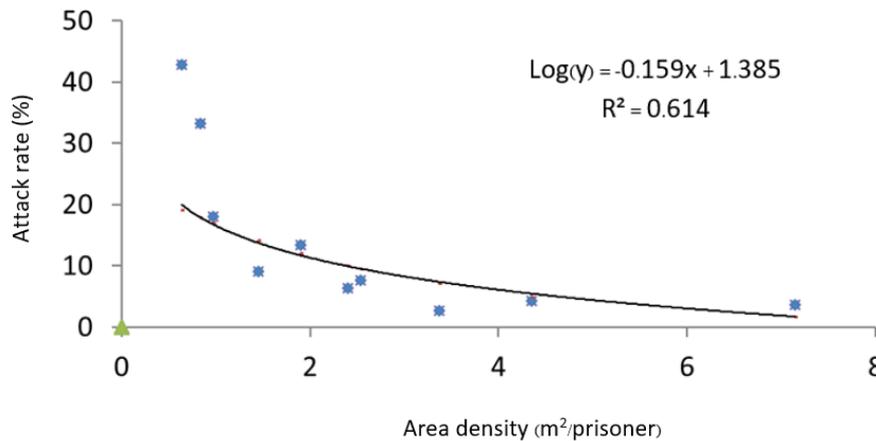
Figure 3. Relationship between attack rate of influenza outbreak by work type and area density in the prison between 16 Jul and 8 Aug 2018

(density >3.2 m^2/person, United Nations[12,13]) it was 3.6%. There was a strong correlation (r = 0.68, *p*-value = 0.025) between the logarithm of the area-specific attack rate and area density (Figure 3).

The daily schedule of prisoners is as follows: wake up at 5.30 AM. Then, practice daily personal hygiene and stand in line for roll call. Breakfast is provided in two sittings: 7.00 and 7.30 AM. Because of the lack of seats, many prisoners sit on the floor during mealtimes. Moreover, food is often served on a plate without a serving spoon. Prisoners usually share glasses used for drinking. Many prisoners had inadequate hand washing due to a time limitation and a lack of hand washing sinks. At 8.00 AM, all prisoners are gathered to listen to the national anthem at the central zone before they are marshaled to other zones. Then, prisoners stay in their dormitory until dawn.

Analytic Study

A total of 217 prisoners were selected using quota sampling. Bivariable and multivariable analysis showed sleeping near an influenza case, adjusted OR = 3.60 (95% CI = 1.62-8.00) and PAF = 33.1%, working near an influenza case, adjusted OR = 3.39 (95% CI = 1.59-7.22) and PAF = 23.4%, and sharing cigarettes with an influenza case, adjusted OR = 2.46 (95% CI = 1.15-4.56) and PAF = 19.7%, were statistically significant (Table 3 and 4).

In 2018, 604 doses of influenza vaccines were provided to the investigated prison. Among the 2,728 prisoners incarcerated, 93 (3.4%) received

the vaccine more than or equal to 2 weeks prior to the outbreak. Five hundred and eleven (18.7%) received the vaccine less than 2 weeks prior to the outbreak, while 2,124 (77.9%) did not receive the vaccine at all within the past 12 months. Among prisoners who received the vaccination more than or equal to 2 weeks prior to the outbreak, the vaccine effectiveness was 25.9% (RR = 0.74, 95% CI = 0.41-1.34). Among those who received the vaccine less than 2 weeks prior to the outbreak, the vaccine effectiveness was 13.8% (RR = 0.86, 95% CI = 0.67-1.11).

Control Measures Implemented

To control the outbreak, influenza cases were isolated until 7 days after the onset of their symptoms. Preventive tools (face mask and alcohol gel) and knowledge (i.e. keeping social distance, avoiding shared personal equipment, washing hand) were provided to prisoners. Oseltamivir was given to 250 cases. Daily screening was established by nurses in the first aid room.

Discussion

An influenza A (H1N1) outbreak occurred in a prison located in the northeast region of Thailand. The virus was the circulating subtype (influenza A (H1N1) pandemic 2009) which has been reported in other recent outbreaks across Thailand.[2] The attack rate was 12.7% which was higher than the annual global attack rate (5–10%) and higher than the median attack rate of an influenza outbreak in a Thai prison in 2018 (6.79, range 2.8-20.5%).[1,2] However, it was

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Table 3. Bivariable analysis of risk and preventive factors associated with influenza sickness (n=217)

Factors	Exposed		Unexposed		Crude RR	95% CI	*p*-value
	Cases	Non-cases	Cases	Non-cases			
Contact history							
• Sleeping near an infuenza case	36	71	11	99	3.36	1.80, 6.25	<0.01
• Working in same area with an influenza case	27	39	20	131	3.09	1.87, 5.10	<0.01
• Sharing table during meal with an influenza case	25	42	22	128	2.54	1.55, 4.17	<0.01
Share personal use							
• Sharing same glass with an influenza case	43	136	4	169	2.23	0.87, 5.98	0.07
• Sharing spoon with an influenza case	4	5	43	165	2.15	0.98, 4.67	0.10
• Sharing cigarette with case with an influenza case	10	34	28	136	2.10	1.28, 3.44	<0.01
Personal hygiene							
• Adequate hand washing with soap	18	82	29	88	0.73	0.42, 1.22	0.23
Risk of introduce source of infection							
• Joining parade competition	1	3	46	167	1.16	0.21, 6.41	0.87
• Using telephone in relative contacting room	27	108	20	61	0.81	0.48, 1.34	0.42
Flu immunization							
• History of recent influenza infection in last 6 months	7	36	40	133	0.70	0.41, 1.63	0.33

lower than two previous outbreaks in prisons.[14,15] There were recent clusters of influenza A (H1N1) outbreaks in three other prisons in the upper northeast region of Thailand. A common factor was a recent parade competition in which many prisoners partook. Cross infection from prison to prison due to this inter-prison activity was suspected.[16,17]

The number of inmates is rising which causes overcrowded prisons. Currently, the occupancy level in the study prison is 280% according to the standard occupancy level for prisons by the International Committee of the Red Cross.[12] The median attack rate was higher in overcrowded areas, and a strong correlation between zone-specific attack rate and area density was identified. In addition, Thailand ranks the sixth in terms of countries with the highest number of inmates.[18]

Table 4. Multivariable analysis of risk and preventive factors associated with influenza sickness (n=217)

Factors	Adjusted OR*	95% CI	Attributable fraction among exposure (%)	Attributable fraction among population (%)
Sleeping near an influenza case	3.48	1.58, 7.60	71.26%	54.99%
Sharing table during meal with an influenza case	1.93	0.90, 4.13	48.19%	20.67%
Working in same area with an influenza case	2.87	1.35, 6.10	65.16%	36.22%
Sharing cigarette with an influenza case	2.16	1.00, 4.63	53.70%	19.12%
Sharing glass with an influenza case	1.86	0.57, 6.03	46.24%	41.39%

Note: *Adjusted for all variables in the table

Between 2017 and 2018, the number of inmates has risen by 163% and the incarceration rate has risen by 128%.[12,19] In 2018, the penitentiary system occupancy level was 304%.[12,19] Therefore, mandatory rehabilitation for drug-related offenses and use of alternatives to prison sentences by developing non-custodial measures within the legal system in line with the United Nations standard minimum rules for non-custodial measures are recommended to address the issue of overcrowding in Thai prisons.[12]

The effective reproductive number during the early period of the outbreak (R = 5.40) was higher than a previous influenza outbreak in a prison in 2009 (R = 4.50) in which control measures were undertaken earlier.[14] Moreover, the reproductive number was decreasing rapidly prior to control measures being undertaken which implies that the decrease may not have been due to the control measure. The multivariable analysis found that sleeping near an influenza case, working in the same area as an influenza case, and sharing cigarettes with an influenza case were significant risk factors, which were consistent with previous studies.[6,20,21] The PAF among all risk factors were not high, thus instead of a single policy, multiple policies is suggested. Use of an isolation area for cases is strongly suggested during influenza outbreaks.[22]

Outbreaks in Thai correctional facility was different to other outbreaks in different settings. Limited staffs and access to vaccines were found to lead to difficulty in outbreak control.[23,24]

The vaccine's effectiveness in this event was lower than that from previous reports in 2017 and 2018 from the US (40%) and among young children in Thailand during 2011 to 2013 (55%).[26,27] One possible reason is that the previous investigations used laboratory-confirmed influenza infections as a case while we combined both suspected and confirmed influenza cases. Therefore, other non-influenza respiratory pathogens may be included. These cases would not have benefitted from the influenza vaccine and therefore we may have underestimated the vaccine's effectiveness.

Limitations

Due to restrictions in the prison setting, we could not implement the planned sampling procedure, which may lead to a non-probability sample and inadequate sample size. However, we could include several subpopulation groups within the prison and used a quota sampling technique, although not statistically representative, which would be acceptable to use in this various and dynamic populations.

Another limitation is that we could not directly observe routine activities before the outbreak,

particularly during the parade competition, which would cause us to miss some risk behaviors during that period. However, consistent information obtained from face-to-face interviews of several prison officers and prisoners helped to increase reliability of this information.

Due to limited resources, the preventive and control measures were not fully implemented leading to the prolonged outbreak.

Recommendations

To prevent future influenza outbreaks, seasonal flu vaccinations for prisoners and staff should be provided prior to the influenza season. Under the limited resources of a corrections facility, the vaccination should be secured for the high-risk groups according to the Thai Clinical Practice Guideline for influenza and, if possible, target vaccination coverage of at least 55% among all inmates should be achieved.[22,23] Moreover, antiviral drugs should be considered in institutional settings.[28] Influenza knowledge, especially symptoms should be enhanced for effective influenza cases detection. Moreover, influenza cases isolation, personal hygiene education and additional equipment such as sinks and drinking water fountains are required to reduce transmission during an outbreak. Lastly, long-term policies are required to solve overcrowded conditions, for example, developing non-custodial measures.

Conclusion

We reported an outbreak of influenza A (H1N1) in a prison setting with an attack rate of 12.7%. The affected population included only prisoners, most of whom were male. Risk factors identified were working and sleeping near an influenza case and sharing cigarettes with influenza cases. The effectiveness of the influenza vaccine among prisoners who received the vaccine more than or equal to 2 weeks prior to the outbreak was higher than that among those who didn't receive the vaccine. A strong correlation between attack rate by work zone and area density was found. We recommend earlier influenza vaccination prior to the influenza season, increasing awareness of the symptoms of influenza for early outbreak detection and having measures to resolve the issue of overcrowding in prisons.

Suggested Citation

Wongsanuphat S, Wonghirundecha T, Boonwisat P, Kerdsalung K, Ploddi K, Sawangjaeng I, et al. Behavioral and environmental factors associated with an influenza outbreak in a prison of Thailand. OSIR. 2019 Sep;12(4):116-125.

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Social Support and Emotional Intelligence of Thai HIV-Affected Adolescents and Their Stress and Alcohol Use

Panithee Thammawijaya[1*], Sung-Jae Lee[2,3], Li Li[2,3], Roger Detels[2]

1 Division of Innovation and Research, Department of Disease Control, Ministry of Public Health, Thailand

2 Department of Epidemiology, Fielding School of Public Health, University of California, Los Angeles, USA

3 Semel Institute, Center for Community Health, University of California, Los Angeles, USA

*Corresponding author, email address: viewfetp@gmail.com

Abstract

There are many concerns about mental and behavioral problems of adolescents having HIV-infected parents (or "HIV-affected adolescents"). This study identifies associations of perceived social support and emotional intelligence of HIV-affected adolescents aged 12-17 years in Thailand with their stress and alcohol use. This study used follow-up data from 173 Thai HIV-affected adolescents and their parents at baseline, 6, 12, 18, and 24 months. Exploratory factor analysis was conducted to develop indicators of adolescents' perceived social support. Bivariate correlation and multilevel model analyses were used to examine predictors of adolescents' stress and alcohol use. While the males reported having a higher number of close friends, greater frequency of calling friends and more social activities than the females, they have less frequency of friend visiting activities. HIV-affected adolescents having higher emotional intelligence reported lower level of stress and less alcohol drinking in the past 30 days. Higher frequency of having alcohol drinking was positively associated with larger friend network and more social activities. Based on the findings, intervention to reduce stress and alcohol drinking among the adolescents needs to address how to improve emotional intelligence and constructive friend and social activities.

Keywords: social support, emotional intelligence, stress, alcohol use, HIV-affected adolescent, Thailand

Introduction

Despite being regarded as one of the most successful countries in confronting the HIV/AIDS epidemic, Thailand is still facing increasing HIV infection rates in some subpopulations particularly in the north and the northeast.[1-3] A large number of HIV-affected families has been estimated in Thailand.[4] Without knowing the exact number of children of people living with HIV/AIDS (PLH), some studies suggested that more than two-thirds of HIV infected adults are married and most couples have 3-4 children.[5,6]

Adolescent children in families whose their parents are infected or have died from HIV/AIDS (or "HIV-affected adolescents") have a higher risks for mental and behavioral health problems compared with general (non HIV-affected) adolescents.[7,8] HIV-infected parent's behavior is found to be the primary determinant of children's adjustment to their parents' infection. HIV-infected people also tend to have pre-existing and long-standing stressors such as poverty, substance abuse and violence.[9,10]

Stress refers to the consequences of the failure of an individual to respond appropriately to emotional or physical threats, whether actual or imagined.[11] Adolescent children of HIV-infected parents are likely to experience high levels of stress.[12-15] Some studies have demonstrated that adolescents of HIV-infected parents tend to have higher risk for substance abuse. In parallel to substance abuse, frequent and early sexual risk behaviors in adolescents are associated

with high levels of emotional distress and low parental monitoring.[16,17]

HIV infection may also be associated with depression, and children of depressed parents are known to be at risk for alcohol and drug abuse in late adolescence and early adulthood.[18,19]

Social support, in social psychology, is defined as "the existence or availability of people on whom we can rely, people who let us know that they care about, value, and love us".[20] The role of perceived social support and mental and behavioral outcomes has been identified among HIV-infected adolescents. It was demonstrated that higher levels of social support are positively associated with lower levels of depression and conduct problems.[21,22]

Emotional intelligence is defined as an individual's ability to monitor one's own and others' emotions, to discriminate between the positive and negative effects of emotions and to use emotional information to guide one's thoughts and actions.[23] Emotional intelligence also reflects the ability of an individual for understanding and managing his/her own emotion, including social skills, and regarded as one supporting factor for a fulfilled life.[24,25] It has been demonstrated that emotional intelligence consistently predicts positive social well-being and academic outcomes in children.[26-28]

Although some studies in the US have suggested a positive effect of perceived social support of HIV-affected adolescents and their lower psychological difficulties such as depressions, its effect on risky behaviors such as substance use and sexual behavior, as well as everyday stress, is yet to be identified particularly in culturally-different areas such as Thailand. This study, therefore, examines associations of perceived social support and emotional intelligence of HIV-affected adolescents aged 12-17 years in Thailand with their stress and alcohol use.

Methods

Study Design and Participants

This study used the data set from a two-year follow-up, randomized, controlled family intervention trial in Thailand.[29,30] These data were collected during 2007-2010 from four district hospitals (two from the north region and two from the northeast region). Families in the study areas with at least one HIV-infected parent, one adult care-giver, and one school-age child were screened. Only families of PLH who had already disclosed their HIV status to their

adult caregivers and adolescent children aged 12-17 years were eligible and invited to participate in the study. After the process of enrollment and informed consent, 204 families had adolescent children aged 12-17 year who were the target of this study. Of those 204 families, 173 (85%) completed a 5-visit follow-up, i.e. at 0 (baseline), 6, 12, 18, and 24 months.

Data Collection

The data were collected by trained interviewers at each district hospitals using a self-administered questionnaire (Computer Assisted Personal Interview) to assess several characteristics of adolescents aged 12-17 years and their PLH parents. A total of 173 adolescents aged 12-17 years and 173 PLH parents were included in this study.

Measurements

Outcome variables

Stress of adolescents was assessed by using a standardized measurement called the "Everyday Stress Index (ESI): Thai adolescent version". In this instrument, there are 26 items asking about common concerns of adolescents with a score ranging from 26 to 104. The measurement was developed by Department of Mental Health, Thai Ministry of Public Health.[31] The measurement had satisfactory internal consistency (Cronbach's alpha = 0.85).

Substance use of adolescents was assessed by using the standardized measurement developed by the US Centers for Disease Control and Prevention. The measurement used in the "Youth Risk Behavior Surveillance System" included 9 questions regarding alcohol and other drug use behaviors.[32] The focus of this study was alcohol use of the adolescents

Sexual behavior of adolescents was assessed using a standardized measurement developed by the US Centers for Disease Control and Prevention. The "Youth Risk Behavior Surveillance System" included 6 questions regarding sexual behaviors. [32]

Predictor variables

Perceived social support of adolescents was assessed using questions adapted from the standardized measurement called the "Medical Outcomes Study (MOS) Social Support Survey".[33] To measure perceived social support of the adolescents more comprehensively, this

study developed new weighted combination scales from three related measures: 1) size of social support mentioned above, 2) caring parenting style score measured using the "Parental Bonding Instrument (PBI): Thai version" which was adapted from the Parental Bonding Instrument developed by Parker and colleagues, 3) plus additional three questions from the standardized measurement, the "Thai Emotional Quotient (Thai EQ) 12-17" asking about opinion concerning acceptance of receiving support from others and about long-time close friends.[34,35] The new two scales were developed and classified into two dimensions: 1) Parental support and personal trait, and 2) Friend network and social activity. Higher scores of both scales suggest higher level of each supportive dimension.

Emotional intelligence of adolescents was assessed using the standardized measurement, the "Thai Emotional Quotient (Thai EQ) 12-17". There are 52 items and the higher scores suggest higher emotional intelligence.[35]

Other covariates

The collected demographics included age in years and gender of the adolescents, and age in years and educational level (primary school or less vs. above primary school) of PLH parents. Self-esteem of adolescents was assessed by using a standardized instrument, the "Rosenberg Self-Esteem Scale".[36] Intervention status of their families and follow-up visit was also included in the regression analysis.

Data Analyses

For the purpose of this study, only the data of adolescents who completed all 5-visits follow-up was analyzed. Exploratory data analysis was conducted. Each measurement and characteristic of interest at baseline was described in terms of mean (and standard deviation) or number (and percentage) according to types of variables (i.e. continuous or categorical variable respectively). Cronbach alpha coefficient was calculated to verify internal consistency of measurement scale. Characteristics between genders were compared using the two-sample t-test (for continuous variables) or Chi-square test (for categorical variables). Pearson correlation coefficients were analyzed to verify bivariate interrelationships among measurements.

Exploratory factor analysis was performed to generate two scales of important dimensions regarding perceived social support from the three related measures mentioned above. The principal component analysis method was used for initial extraction and oblique rotation (direct quartimin procedure) was conducted to identify the best variable combination scales. Standardized factor score assigning was done using a regression procedure.

Multilevel regression models were used to estimate associations between outcomes of interest and their potential predictors and covariates due to hierarchical structure of the dataset (i.e. five observations over two years of each adolescent who were from four communities). Potential variables to be included in the final models were selected based on prior knowledge, statistical criteria, and subjective interest. Follow-up visit was also included in the model as indicator variables to assess potential associations between outcomes and time of follow-up. For selection of the final model, best subset regression with forcing of some important variables was performed. Standardized coefficients and *p*-values are reported for continuous outcomes. Adjusted odds ratios and 95% confidence intervals (95% CI) are reported for dichotomous outcomes.

All statistical analyses were conducted with R software.[37]

Ethical Approval

This study was reviewed and approved by Institutional Review Boards of the University of California at Los Angeles, and the Thailand Ministry of Public Health Ethical Review Committee for Research in Human Subjects.

Results

Of those 204 families with adolescent children aged 12-17 year, 173 (85%) completed 5-visit follow-ups and were analyzed in this study. There is no significant difference in important baseline characteristics (including age, gender, everyday stress index, alcohol, smoking and sexual behaviors) between those 173 families retained and 31 families loss to follow up. Baseline characteristics of 173 HIV-affected adolescents and their PLH parents are illustrated in Table 1. About 57% of the 12 to17-year-old adolescents were female. The average age of the adolescents was 13.8 years (standard

Table 1. Baseline characteristics of HIV-affected adolescents and their PLH parents, Thailand

Characteristics	Total (N = 173) N (%)	Female (N =98) N (%)	Male (N = 75) N (%)	*p*-value
Adolescents				
Age*	13.8 (1.5)	14.0 (1.6)	13.5 (1.4)	0.026
Study site				0.240
Site 1	63 (36.4)	34 (34.7)	29 (38.7)	
Site 2	37 (21.4)	19 (19.4)	18 (24.0)	
Site 3	38 (22.0)	27 (27.6)	11 (14.7)	
Site 4	35 (20.2)	18 (18.4)	17 (22.7)	
Stress (α=0.85)*	38.7 (10.7)	38.8 (9.6)	38.7 (11.9)	0.942
Ever drunk alcohol	55 (31.8)	36 (36.7)	19 (25.3)	0.111
Ever smoked cigarette	27 (15.8)	16 (16.7)	11 (14.7)	0.722
Ever had sexual intercourse	33 (19.1)	20 (20.4)	13 (17.3)	0.610
Number of close friends and close relatives*	3.7 (2.8)	3.3 (2.5)	4.3 (3.0)	0.018
Number of social activities from your home past week*	2.9 (2.6)	2.4 (1.9)	3.5 (3.2)	0.008
Number of times you spoke with friends on the phone past week*	2.8 (2.4)	2.4 (2.0)	3.2 (2.8)	0.046
Number of times visiting friends' houses/your friends visited your house*	3.3 (4.1)	4.2 (4.3)	2.3 (3.4)	0.004
Having at least one best friend	163 (94.2)	92 (93.9)	71 (94.7)	0.826
Self-esteem (α=0.67)*	28.9 (2.8)	28.8 (2.5)	29.0 (3.2)	0.739
Emotional intelligence (α=0.83)*	152.1 (15.6)	151.7 (15.5)	152.6 (15.9)	0.728
Parents				
Age	39.4 (5.7)	39.1 (5.4)	39.8 (5.9)	0.372
Female gender	127 (73.4)	69 (70.4)	58 (77.3)	0.307
Highest education				0.373
Primary school or less	145 (83.8)	80 (81.6)	65 (86.7)	
Above primary school	28 (16.2)	18 (18.4)	10 (13.3)	
Received intervention	100 (57.8)	57 (58.2)	43 (57.3)	0.913

Note: *mean (standard deviation)

deviation [s.d.] = 1.5). The mean of everyday stress index scale was 38.4 (s.d. = 10.7). Among 173 adolescents, 55 (31.8%) reported that they had ever drunk alcohol in their lifetime, 25 (17.8%) reported that they had ever smoked cigarette in their lifetime. For sexual behavior, 33 (19.1%) adolescents reported that they had ever had sexual intercourse in their lifetime. Of note, although not statistically significant, female adolescents had higher proportion of engaging in all of the above unfavorable behaviors than male adolescents in this study Male adolescents reported significantly higher number of close friends, number of social activities away from house, and number of phone calls to their friends than did female adolescents. However, female adolescents reported significantly a higher number of times visiting friends' houses or being visited by friends at their houses than did male adolescents. The self-esteem of the adolescents had a mean of 28.9 (s.d. = 2.8). The average emotional intelligence was 152.1 (s.d. = 15.1). For the PLH parents of those adolescents, average age was 39.4 (s.d. = 5.7) and 73.4% of them were female. Only 16.8% of these parents had completed an education level above primary school.

Table 2 outlines the standardized factor scores for perceived social support of the adolescents using exploratory factor analysis. Factor 1 had more weights on caring parenting style (item 5) and adolescents' characteristics concerning receiving support (items 6-8) with scoring coefficients ranging from 0.33 to 0.39. Factor 2

Table 2. Scoring coefficients for social support and related variables from exploratory factor analysis

Item	Description	Factor 1	Factor 2
1.	No. close friends and close relatives	-0.004	0.284
2.	No. of social activities from you home past week	-0.032	0.492
3.	No. of times you spoke with friends on the phone past week	-0.044	0.448
4.	No. of times you visited friends' homes/your friends visited your home	0.135	0.232
5.	Caring parenting style	0.334	-0.091
6.	Do you think it is worth in sympathy that others display towards me	0.368	-0.071
7.	Do you think you can easily make acquaintances with others	0.389	0.0004
8.	Do you think you have many close friends that you have known for a long time	0.379	0.03642
	variance explained	1.79	1.70
	percentage	22.3	21.3

had more weights on number of close friends and close relatives (item 1) and numbers of contacts or social activities (items 2-4). Adolescents' scoring coefficients ranged from 0.23 to 0.49. Since the exploratory factor analysis was conducted to identify "hidden" dimensions (or aspects) of social support measures, the findings in Table 2 indicated that factor 1 and factor 2 represented two different dimensions of social support. Factor 1 can be seen as the main combination of parental support and personal trait while factor 2 is highly focused on friend network and social activity. In the following analyses, factor 1 and factor 2 will be used as two single variables representing the two relevant dimensions mentioned above.

Bivariate correlations among stress, factor 1, factor 2, emotional intelligence, self-esteem, and age in years are presented in Table 3. Stress was negatively correlated with the factor 1 ($r = -0.25$, $p = 0.003$) and emotional intelligence ($r = -0.19$, $p = 0.02$) but was positively associated with self-esteem ($r = 0.18$, $p = 0.02$). We found that adolescent with higher levels of factor 1 reported a higher level of emotional intelligence ($r = 0.62$, $p <0.001$) and self-esteem ($r = 0.36$, $p <0.001$). A positive association between age and the factor 1 ($r = 0.18$, $p = 0.02$) was observed. Lastly, there was a positive association between emotional intelligence and self-esteem ($r = 0.42$, $p <0.001$)

Table 3. Bivariate correlations among characteristics of interest at baseline

Characteristics	1	2	3	4	5	6
1. Stress	1					
2. Social support factor 1: parental support and personal trait	-0.25*	1				
3. Social support factor 2: friend network and social activity	0.03	-0.05	1			
4. Emotional intelligence	-0.19*	0.62**	-0.05	1		
5. Self-esteem	0.18*	0.36**	-0.10	0.42**	1	
6. Adolescent's age	0.04	0.18*	0.07	0.03	0.03	1

Note: *$p <0.05$, **$p <0.001$

Table 4. Associations of everyday stress* with perceived social support, emotional intelligence, and self-esteem among HIV-affected adolescents over five-visit follow-up (at baseline, 6, 12, 18, and 24 months) from the multilevel model**

Correlates	Standardized coefficient	p-value
Social support factor 1: parental support and personal trait	0.02	0.699
Social support factor 2: friend network and social activity	0.01	0.654
Emotional intelligence	-0.19	<0.001
Self-esteem	-0.05	0.132
Adolescent's gender	0.00	0.984
Adolescent's age	0.12	0.013

Note: *Logarithmic transformed

**Other covariates in the models included age and educational level of PLH parents, and intervention status

Table 4 presents the multilevel regression model examining the association between stress of the adolescents and potential predictors. After controlling for age and gender of the adolescents, age and educational level of PLH parents, and intervention status, we found a significant negative association between stress and emotional intelligence (standardized coefficient [b] = -0.19, p <0.001). Adolescents higher age were reported significantly higher stress (b = 0.12, p = 0.01).

The multilevel model for alcohol drinking was demonstrated in Table 5. When controlling for age and gender of the adolescents, age and educational level of PLH parents, and intervention status in the model, we found that adolescents with higher emotional intelligence were less likely to report drinking alcohol in past 30 days (adjusted OR = 0.96, 95% CI = 0.93-0.98). But level of friend network and social activity was positively associated with alcohol drinking in past 30 days (adjusted OR = 1.88, 95% CI = 1.33-2.66). Finally, significant positive association between alcohol drinking and adolescents' age was observed (adjusted OR = 1.83, 95% CI = 1.45-2.31). We did not see any significant association between follow-up time

Table 5. Associations of alcohol drinking* with perceived social support, emotional intelligence, and self-esteem among HIV-affected adolescents over five-visit follow-up (at baseline, 6, 12, 18, and 24 months) from the multilevel model**

Correlates	Odds ratio	95% Confidence interval	
		Lower	Upper
Social support factor 1: parental support and personal trait	1.32	0.88	1.97
Social support factor 2: friend network and social activity	1.88	1.33	2.66
Emotional intelligence	0.96	0.93	0.98
Self-esteem	1.06	0.93	1.20
Adolescent's gender	1.47	0.72	3.04
Adolescent's age	1.83	1.45	2.31

Note: *Having at least one drink of alcohol in past 30 days

**Other covariates in the models included age and educational level of PLH parents, and intervention status

and outcomes of interest, i.e. stress and alcohol drinking, therefore the indicator variables of follow-up visit were excluded from the final multilevel model presented in Table 4 and Table 5.

Discussion

To our knowledge, no empirical data about stress, substance use and sexual behavior of Thai HIV-affected adolescents has been documented to date. This present study is one of the first studies that explored those mental and behavioral factors and their associations with perceived social support and emotional intelligence of HIV-affected adolescents in Thailand. We found that emotional intelligence predicts adolescent's stress and alcohol consumption behavior. From our study, HIV-affected adolescents having higher emotional intelligence reported a lower level of stress and less alcohol drinking. These findings are consistent with the theory that emotional intelligence influences the ability of individuals to monitor and manage their own feeling and cope when confronting with stressors.[38,39] Some researchers demonstrated that emotional intelligence was negatively associated with substance uses, including alcohol and tobacco, among adolescent in the US. They also proposed that adolescents with high emotional intelligence might have better mental ability to read other persons' mental or emotional status and therefore can avoid unwanted pressure from their friends.[40]

Our study also identified some differences in sizes of friend network and social activities between female and male adolescents. While male adolescents reported having higher number of close friends, times speaking with friends on the telephone and number of social activities outside their houses when compared with females, they had less frequency of friend visiting activities (i.e. visiting friends' houses or being visited by their friends). This finding indicates the different nature of social activities between Thai female and male adolescents and may have practical implications if public health officers wish to design supportive interventions for HIV-affected adolescents through peer-assisted strategies. Additionally, based on multilevel model analysis, higher frequency of alcohol drinking was positively associated with increasing score of friend network and number

of social activities. This finding is consistent with the past study in Thailand which observed that alcohol consumption behavior of university students was significantly associated with peer drinking, relatives drinking, accessibility of alcohol in the surrounding community, and other predictors.[41]

As with other research, a few limitations in this present study should be noted. Firstly, the samples were drawn from PLH families who had disclosed their status and might not represent all HIV-affected families in Thailand. Additionally, because of non-randomized nature of observational data, retrospective data collection, complex relationship of characteristics of interest, and covariate-outcome across follow-up time, a causal relationship cannot be established. However, by using repeated observations on the same person over five visits, instead of analyzing one-visit data cross-sectionally, we can reduce confounding by unmeasured time-constant individual characteristics.

Conclusions and Recommendations

In sum, this study underscored the role of emotional intelligence as an important predictor of Thai HIV-affected adolescent stress and alcohol drinking. Furthermore, size of friend network and social activities are also related to alcohol drinking. As stress and alcohol drinking are not uncommon challenges in adolescents particularly ones living in HIV-affected families, intervention aiming to improve emotional intelligence and constructive friend and social activities could be beneficial to HIV-affected adolescents.

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Suggested Citation

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Outbreak of Human Streptococus suis Cases in Chum Phuang District, Nakhon Ratchasima Province, Thailand, 2018

Nilubon Karavanonth[1], Inchat Sukkasem[1,3], Siriporn Songkram[2], Chuleeporn Jiraphongsa[3]

1 Division of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand

2 Chum Phuang Hospital, Nakhon Ratchasima Province, Thailand

3 The Office of Disease Prevention and Control 9, Nakhon Ratchasima Province, Thailand

*Corresponding author, email address: zi-kuza@hotmail.com

Abstract

Streptococcus suis (*S. suis*) is a major public health problem in northeastern Thailand. On 17 Apr 2018, the Office of Disease Prevention and Control 9 received a notification of five patients with *S. suis* infection in Chum Phuang District, Nakhon Ratchasima Province. We investigated to confirm the etiology, describe the epidemiological characteristics, and identify the source of this outbreak. Medical records and laboratory results at the district and provincial Hospitals were reviewed. We interviewed family members and people who shared meals with cases. We surveyed slaughter processes at two implicated slaughterhouses. Surveillance for *S. suis* cases was also enhanced. Six confirmed cases of *S. suis* serotype 2 infection were found in six sub-districts of Chum Phuang District between 1 Jan and 20 Apr 2018. Clinical presentations of confirmed cases were fever (100%), headache (50%) and hearing loss (50%). Five of the six cases ate raw pork with an average incubation period of 2.3 days. Those who ate raw pork were more likely to get infected (RR = 13.5, 95% CI = 1.7-105.1). One from 27 specimens identified *S. suis* serotype 7 from a slaughterhouse in Chum Phuang District. The outbreak continued with an additional 14 confirmed cases in province during the monitoring period from 20 Apr to 25 Jul 2018. Increasing health awareness of the public and physicians beyond ensuring proper management in slaughterhouses should be strengthened.

Keywords: *Streptococcus suis*, zoonosis, outbreak, raw pork, slaughterhouses, Thailand

Introduction

Streptococcus suis (*S. suis*) is a Gram-positive, facultative anaerobic bacteria that causes meningitis, septicemia, and arthritis in pigs. There are 33 serotypes and serotype 2 is the most frequently isolated.[1,2] *S. suis* is a zoonotic pathogen that causes invasive infections in humans and is always caused by *S. suis* serotype 2. Most infections are associated with close contact with infected pigs or contaminated pork-derived products. *S. suis* is likely to be due to translocation across the intestines of human hosts who have liver disease and/or consume alcohol. The bacteria can be cultured from cerebrospinal fluid or blood, and serotypes could be identified by multiplex polymerase chain reaction (PCR).[3] However, culture results can be negative as a result of antibiotic use before the collection of specimens. Many reports come from countries where pig raising and pork processing

are of great importance.[4] The average incubation period ranges from a few hours up to 2.2 days with some lasting up to 14 days.[5,6]

S. suis has been a major public health problem in Thailand, especially in the northern and northeastern regions. The main route of infection in humans in these areas is by ingestion due to consumption of raw pork and meat products. In a retrospective study in 2006-2008 in northern Thailand, *S. suis* infection was confirmed by blood culture or cerebrospinal fluid specimens from 179 patients who had close contact with infected pigs or contaminated pork-derived products. Human infection with serotype 2 was the most common (92%) with a case fatality of 9.5%.[7]

Nakhon Ratchasima Province is the biggest province in the northeastern region of Thailand[8] that reported many cases of *S. suis*. On 17 Apr 2018, the Office of Disease Prevention and Control 9 received notification

from Nakhon Ratchasima Provincial Health Office of five patients with *S. suis* infection in the same district. The objectives of this investigation were to confirm the etiology, describe the epidemiological characteristics, and identify the source of this outbreak.

Methods

Confirmation of the Outbreak and Risk Factors Identification

We reviewed the National Notifiable Disease Surveillance System (R506) during 2010-2017 in order to confirm the outbreak and identify risk factors. Physicians and laboratory technicians at Maharat Nakhon Ratchasima Hospital and Chum Phuang District Hospital were interviewed to confirm the diagnoses and determine their laboratory methods. Medical records and laboratory results at the district and provincial hospitals were reviewed.

A suspected case was defined as any patient diagnosed with unspecified meningitis, unspecified septicemia, or unspecified hearing loss and lived in Chum Phuang District during 1 Jan to 20 Apr 2018. A confirmed case was defined as a patient with laboratory confirmation of *S. suis* infection by PCR method ata standard laboratory. Active case finding was conducted through review of medical records and laboratory results at Maharat Nakhon Ratchasima Hospital and Chum Phuang District Hospital. Family members and neighbors of the infected cases were interviewed to identify new cases.

Following a retrospective cohort design, a group of people was formed from family members, neighbors and people who shared meals with the reported cases during the previous two weeks. Persons who may have been exposed to contaminated food items related with the reported cases were also recruited. We interviewed the reported cases and involved people previously described using a structured questionnaire. Variables collected included demographic characteristics, risk factors, clinical manifestation and laboratory results. Analysis of potential risk factors of *S. suis* infection was performed by calculating the risk ratio (RR) with a 95% confidence interval (CI). The consumption of raw pork was divided into 4 ordinal categories, including not eating, tasting, eating normally and eating until full. The association was explored using a chi-square test for trend. Potential risk factors were analyzed by univariate method and all potential risk factors were included in the multivariate logistic regression analysis.

Environmental Study

Two implicated slaughterhouses in Chum Phuang District were surveyed for slaughtering processes. Specimens collected at these slaughterhouses included tonsil glands, raw pork meat and blood of live pigs before being slaughter and sent to the Veterinary Research and Development Center of Lower Northeastern Region), Surin Province, for PCR testing to identify *S. suis* serotypes.

Results

Situation of *Streptococcus suis* Infection

Nakhon Ratchasima Province is one of the four provinces in Health Region 9. As shown in Figure 1, the rate of *Streptococcus suis* infection per 100,000 population identified in Nakhon Ratchasima Province was higher than the situation reported by Health Region 9 and the whole country. There were 239 cases (attack rate 9.0 per 100,000 population) and 23 deaths from *S. suis* infection reported in Maharat Nakhon Ratchasima Hospital during 2010-2017. Peaks occurred during April and June every year. Patients aged over 65 years had a significantly higher risk of death. In 2017, there were 53 cases (attack rate 2.0 per 100,000 population). The highest number of cases was from Muang District, with 10 cases (attack rate 4.6 per 100,000 population) but there was only 1 case in Chum Phuang District (attack rate 1.3 per 100,000 population).
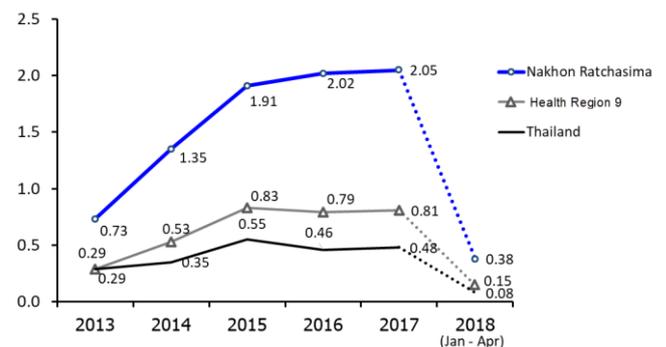
Figure 1. Situation of *Streptococcus suis* infection inNakhon Ratchasima Province, Health Region 9.and Thailand, 2013-2018 (rate per 100,000 population)

Note: Data source: Office of Disease Prevention and Control Region 9 (ODPC9)

Description of the Outbreak

From the active case finding, in total we found six confirmed cases of *S. suis* infection during 1 Jan to 20 Apr 2018. All cases were distributed in six separate sub-districts out of a total of nine sub-districts in

Chum Phuang District. The morbidity rate in Chum Phuang District was 9.9 per 100,000 population. No death was reported. The index case was found on 1 Apr 2018 and the primary case was found on 7 Mar 2018. All six confirmed cases ate pork from a different place, but their symptoms occurred during the same time period. Table 1 shows details of the six confirmed cases. Five of the six cases ate raw pork and had an average incubation period of 2.3 days (range 1–7 days). Most cases were farmers (40.3%).

All confirmed cases were positive for *S. suis*, including one case by cerebrospinal fluid culture, three cases by blood culture, and two cases by both blood and cerebrospinal fluid culture. All specimens contained *S. suis* serotype 2. The median age of cases was 56.5 years (range 46-68 years). All cases were male and current drinkers. All cases were admitted to Maharat Nakhon Ratchasima Hospital. Clinical presentations of confirmed cases included fever (100.0%), headache (50.0%), hearing loss (50.0%), myalgia (50.0%), stiffness of neck (50.0%) and signs of shock (16.7%).

From the patient interviews, all said that they recently ate raw or semi-cooked pork products. Two bought raw pork at Chum Phuang fresh market while four bought cooked pork from barbeque restaurant or at local mobile food vendors. Further investigations revealed that three of the six cases ate raw pork that came from two slaughterhouses (A and B) located in Chum Phuang District.

Identification of Risk Factors

A total of 63 persons were enrolled in the retrospective cohort study, including the six confirmed cases, one suspected case and 55 non-cases. The male to female ratio was 1:1 and the median age was 46 years (range: 5 months - 73 years).

From bivariate analysis, eating raw pork was a significant risk factor with a risk ratio (RR) of 13.5 (95% CI = 1.75-105.1, p = 0.001), as shown in Table 2. There was a positive dose-response relationship between the amount of raw pork eaten and being ill(test for trend: p-value = 0.002). The results of the multiple logistic regression analysis are shown in Table 3. After adjusting for gender and alcohol consumption, those who ate raw pork were 15.0 times more likely to have confirmed *S. suis* infection compared to those who did not (% CI=1.55-144.8).

Table 1. Confirmed *Streptococcus suis* cases during 1 Jan to 20 Apr 2018 in Chum Phuang District, Nakhon Ratchasima Province

No.	Case	Place	Onset	Date of exposure	Type of food	Source of food	Source of raw material
1	Male 46 yr.	Chum Phuang	07/03/2018	06/03/2018	BBQ Pork	K BBQ pork restaurant	Makro super market
2	Male 52 yr.	Pasuck	28/03/2018	27/03/2018	Raw pork salad	Chum Phuang fresh market	Slaughterhouse A
3	Male 53 yr.	Talad	28/03/2018	27/03/2018	Raw pork salad	Chum Phuang fresh market	Slaughterhouse A
4	Male 59 yr.	Nonyoo	31/03/2018	28/03/2018	Raw pork salad with pork blood	Mobile market A	Unknown
5	Male 61 yr.	Nonglak	01/04/2018	24/03/2018	Raw pork salad	Mobile market B	Slaughterhouse B (Bangyai District)
6	Male 68 yr.	Noonrang	01/04/2018	Almost every day	Raw pork salad	Fresh market in the village	Slaughterhouse C

Table 2. Bivariate analysis of risk factors for *Streptococcus suis* infection in Nakhon Ratchasima Province, 2018 (n=63)

Exposure factor	Exposure			Non-exposure			Risk ratio	95%CI	
	Case	Non case	Attack rate	Case	Non case	Attack rate		Lower	Upper
Eating raw pork vs not eating raw pork	6	13	31.6%	1	43	2.33%	13.5	1.75	105.1
Male	6	25	19.3%	1	31	3.1%	6.2	0.79	48.52
Alcohol consumption	6	24	20.0%	1	32	3.0%	6.6	0.84	51.7
Smoking	4	16	20.0%	3	40	7.0%	2.87	0.70	11.6

Table 3. Multivariate analysis of risk factors for *Streptococcus suis* infection in Nakhon Ratchasima Province, 2018

Risk Factor	Adjusted OR	95% CI
Male	3.71	(0.25-55.72)
Alcohol consumption	2.18	(0.14-33.88)
Raw pork consumption	14.96	(1.55-144.81)

Environmental Survey

Four slaughterhouses situated close to the outbreak area were investigated, of which two (A and B) were located in Chum Phuang District. We observed the environments and slaughter processes (Figure 2) with the following results.

Slaughterhouse A had 5 employees who started working at 8 PM. Around7-10 pigs were usually killed per session.

Process in slaughterhouse A:

1. The pigs are marshaled at the front of the slaughterhouse.

2. The pigs walk into slaughterhouse.

3. Inside the slaughterhouse, the pigs are stunned with an electrical current until they are unconscious.

4. The pigs are hoisted on a rail and hung head-down before killing them with a stabbing knife and exsanguinations occurs.

5. The pigs are put in a rolling machine under boiling water to remove the hairs from the skin.

6. After removal from the boiler, the pigs are placed on a cutting board to remove the head and slit the testicles. The pigs are then sent for dissection.

In slaughterhouse B, there were 2 employees who worked from 6 PM to 6 AM. One pig is killed per session.

Process in slaughterhouse B:

1. The pig is stunned by hitting it on the head three times.

2. While the pig is lying on its side, its throat is pierced and one of the employees steps on the pig to push the blood out.

3. The pig is boiled to remove the hairs from the skin.

4. One of the employees steps on the pig for assistance with evisceration.

5. The employees dissect the pig on a big wooden block.

Figure 2. Pig slaughtering process in a slaughterhouse, Chum Phuang District, Nakhon Ratchasima Province, 2018

Figure 3. Slaughtering process in a slaughterhouse, Chum Phuang District, Nakhon Ratchasima Province, 2018

Laboratory Results

We collected 25 raw pork specimens including fresh blood, tonsil, and skin from four pigs. Two samples were collected from prepared pork salads that were processed in two slaughterhouses in Chum Phuang District. *S. suis* serotype 7 was found by PCR in one of five (20%) collected tonsil specimens. All raw pork salads and whole blood from live pigs were negative (Table 4).

Table 4. Raw pork specimen results in Chum Phuang District, Nakhon Ratchasima Province, 2018

Place	Number of specimens			Laboratory result
	Blood	**Tonsil**	**Skin**	
Slaughterhouses	5	5	15	1 tonsil specimen positive for *Streptococcus suis* serotype 7
Market	2	-	-	Negative

Discussion

Six confirmed cases of *S. suis* infection were identified in Chum Phuang District between 1 Jan to 20 Apr 2018.

All cases consumed raw pork before becoming ill. All confirmed cases lived in different sub-districts and they ate pork from different sources. Though eating raw pork was a risk factor for infection, the source of infection could not be identified. Pig specimens obtained from implicated slaughterhouses was found to be serotype 7.

The outbreak of *S. suis* serotype 2 was similar to previous outbreaks in Thailand, resulting from the consumption of raw pork meat or blood. No case was found in swine farmers or butchers.[9] For one case, we suspected that his illness came from eating barbeque pork. Although *S. suis* is easily destroyed by heat, it should be cooked at a temperature of at least 70° C for at least 10 minutes.[2] In this outbreak all cases ate raw pork, and the specimens of confirmed cases were due to serotype 2. Recently, epidemiological investigations proposed that pigs in slaughterhouses could be a major reservoir of *S. suis* serotype 2 with a capacity to cause human infections, but in this outbreak the pig specimens were found to be serotype 7. Previous studies reported that out of 33 serotypes of *S. suis*, serotype 2 was the most frequently isolated in humans. However, human cases of serotypes 1, 4, 5, 14, 16 and 24 have also been reported.[9,10]

It is unlikely that source of the outbreak was the same pig since the six cases all lived in different sub-districts. Eating raw pork is a cultural norm in northeastern Thailand, and most villagers do not know that eating raw pork increases the risk of illness. This study suggests that the raw pork products consumed by most of the cases were contaminated with *S. suis*. In Chum Phuang District, most raw pork products are supplied from local slaughterhouses to the local markets. A recent study of *S. suis* serotype 2 infection reported that slaughterhouse pigs were the source of

infection in southern Vietnam.[14] A previous study in Hong Kong reported that an increase in bacterial density of *S. suis* in raw pork meats in local markets occurs in hot and humid weather.[15] The poor quality of food safety control for raw pork products at the local markets was likely to provide the sources of this infection.

The first report of *S. suis* infection was in Denmark in 1968 and the mode of transmission was thought to be direct contact.[11] In 2005, a large outbreak occurred in Sichuan Province of China, with 215 cases and 62.3% deaths due to streptococcal toxic shock syndrome.[12] In Thailand in 1987, the first cases of *S. suis* infection was reported related to raw pork product consumption. Since, then over 200 cases have been reported per year in Thailand. In Nakhon Phanom Province of northeastern Thailand among 38 hospitalized cases during 2006-2012, 85% had meningitis and 54-80% suffered from hearing loss after recovery.[13] The clinical characteristics of *S. suis* infection were similar in patients with bacterial meningitis caused by other microorganisms, such as *N. meningitis* and *S. pneumonia*. However, the mortality associated with *S. suis* meningitis was lower than that with bacterial meningitis caused by other pathogens.[19] Skin rash, distal necrosis, jaundice, and renal failure were observed in a number of patients. These symptoms and signs were also observed during the outbreak of *S. suis* infection in China during 2005 and were suggested to form part of a streptococcal toxic shock syndrome.[11] The most striking feature of *S. suis* meningitis is the progressive hearing loss, resulting in mild-to-severe deafness in two-thirds of patients. The pathogenesis of the hearing loss in *S. suis* meningitis is unknown. Studies in guinea pigs have shown direct invasion of the cochlea by *S. suis*.[10] In this investigation, half of confirmed cases also had hearing loss.

Limitations

Suspected foods could not be collected as most patients were investigated after three weeks of developing symptoms. Information about pork eating behaviors and symptoms may be subject to recall bias. As a result, we could not link the cases with the meat vendors or the slaughterhouses. Moreover, we could not collect implicated pork samples and there was a lack of information about the health of the pigs in this area.

Actions Taken

Health education on *S. suis* infection and warnings to avoid eating raw pork were provided through community radio stations, village broadcast and posters. Training workshops to refresh the knowledge of this disease to health care workers were organized in Chum Phuang Hospital. Group discussion sessions were held in villages with patients, staff from district health departments and primary health care units. District livestock officers randomly check raw pork products in Chum Phuang District every 6 months to detect *S. suis*.

Surveillance for *Streptococcus suis* cases was enhanced for one month after the investigation took place. For patients who had signs of systemic inflammatory response syndrome, Hospital staff would collect specimens for laboratory testing and ask about the history of eating or contact with raw pork and report to the Surveillance and Rapid Response Team. From the Hospital-based surveillance we found two cases were diagnosed with *S. suis* having history of eating raw pork and having signs of systemic inflammatory response syndrome. These patients were referred to Maharat Nakhon Ratchasima Provincial Hospital.

Monitoring the Disease Situation

After this outbreak investigation, the local team continued to monitor the disease situation in Maharat Nakhon Ratchasima Provincial Hospital. They found no new cases in Chum Phuang District but 14 cases, including five deaths, were confirmed in Nakhon Ratchasima Province from other districts between 20 Apr and 25 Jul 2018. It was likely that in Chum Phuang District, villagers were more aware about *S. suis* infection than people from the other Districts, who were still eating raw pork, as reported by all 14 cases. All cases were confirmed to have *S. suis* serotype 2. The median age of the cases was 59 years (range 34-95 years). The common symptoms were fever (93.8%), muscle pain (87.5%) and headache (75.0%).

After the Chum Phuang outbreak we monitored and collected 51 raw pork specimens including fresh blood, tonsil, and skin from three slaughterhouses in Nakhon Ratchasima Province. Two tonsil specimens tested positive to *S. suis* serotype 2. Three samples of blood, tonsil, and skin were found to have an unidentified serotype of *S. suis*.

Recommendations

The provincial public health office should advise people to stop eating raw pork meat and blood and provide health education in areas where this type of food is sold. Chum Phuang Hospital should develop a

monitoring program for *S. suis* infection. When detecting patients who have any symptoms after eating raw pork meat or blood in hospitals, tests for *S. suis* should be done immediately. Behavioral studies of eating raw pork in communities are recommended for Thailand. Slaughterhouses should follow the recommended guidelines[16,17] in the transportation, pre-slaughter and slaughter processes to reduce the spread of infection.

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Suggested Citation

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Field Evaluation of the Syphilis Surveillance System at Mae Sot Hospital, Tak Province, Thailand

Yu Nandar Aung[1*], Ni Win Htike[2], Min Myo Kyi[3], Chanodom Piankusol[4], Sahrol Azmi Terlmizi[5], Kosal Sreang[6], Thanawadee Chantian[7], Onpirun Sagarasearanee[8], Bencharong Sangkharak[9], Purnama Martha Oktavia Simanjuntak[10], Khanuengnij Yueayai[11], Rapeepong Suphanchaimat[7,12], Pitikhun Setapura[7], Thanit Rattanathamsakul[7]

1 East District Public Health Department, Yangon, Ministry of Health and Sports, Myanmar

2 Aunglan Township Public Health Department, Ministry of Health and Sports, Magway, Myanmar

3 Vector Borne Disease Control Division, Ministry of Health and Sports, Kayin State, Myanmar

4 Faculty of Medicine, Chiangmai University, Thailand

5 Pahang State Health Department, Ministry of Health, Malaysia

6 Department of Communicable Disease Control, Ministry of Health, Cambodia

7 Division of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand

8 Division of Communicable Disease, Ministry of Public Health, Thailand

9 Department of National Parks, Wildlife, and Plant Conservation, Ministry of Natural Resources and Environment, Thailand

10 Directorate of Animal Health, Ministry of Agriculture, Indonesia

11 Office of Prevention and Control 9, Department of Disease Control, Ministry of Public Health, Thailand

12 International Health Policy Program, Ministry of Public Health, Thailand

*Corresponding author, email address: girlyunandar2012@gmail.com

Abstract

Evaluation of the syphilis surveillance system was conducted at Mae Sot Hospital, Mae Sot District, Tak Province, Thailand during 13-16 Aug 2019. The objectives of the evaluation were to describe the usefulness and to evaluate the performance of the system. A cross-sectional study was carried out to assess the reporting system of syphilis. Medical records were reviewed from all possible data sources. Semi-structured questionnaires were used for in-depth interviews with a policy maker, health care providers, laboratory technicians and information and technology personnel. The sensitivity of reporting syphilis cases into Thailand's national notifiable disease surveillance reporting system was about 67%, while the positive predictive value of reporting was reached 100%. The data quality of reporting reached almost 100%. The reported data represented the true cases in terms of sex and age. The majority of participants found the reporting system of syphilis cases to be useful, acceptable, simple and stable. The majority of missed reported cases were migrants. Incomplete diagnosis and coding were key concerns. The Epidemiology Unit at the hospital should analyze Thai and foreign cases separately to represent the true situation in the border area. Cooperation amongst within-hospital units for better capture of syphilis cases in hospital is recommended.

Keywords: syphilis, surveillance system, reporting system, Thailand

Introduction

Syphilis is a bacterial infection caused by *Treponema pallidum*. It is transmitted via sexual contact of mucous membranes or abraded skin, via the placenta of a pregnant woman to her foetus, or via a blood transfusion. The disease has four stages: (1) primary syphilis, (2) secondary syphilis, (3) latent syphilis, and (4) congenital syphilis.[1] According to a World Health Organization report, there were approximately 17.7 million syphilis cases among people aged between 15 and 49 years worldwide in 2012.[2] In 2017, the prevalence of syphilis among antenatal care attendees ranged from 1.0-8.0% in 37 of 83 reporting countries; over 5.0% of sex workers were infected in 18 of 31 reporting countries; and the prevalence of infection was 5.0% greater among men having sex with men in 22 of 34 reporting countries.[3]

An overview of syphilis in Thailand found that the prevalence has increased dramatically since 2000 despite a significant decrease in syphilis cases in the 1990s. From 2005 to 2011, significant increases occurred in the annual prevalence of HIV (from 24.6% to 29.4%) and syphilis (from 5.0% to 12.5%).[4]

In 2018 there were a total of 177 cases of syphilis in Tak Province. Among them, Mae Sot District was the most prevalent area, accounting for 120 cases (68%), of which 70% were non-Thais and were mostly labourers and students.[5] Mae Sot is a District with one of the highest incidence and prevalence of syphilis in Thailand. Moreover, the surveillance system of syphilis has never been officially evaluated in Thailand. This study is therefore likely to be one of the first studies that scientifically evaluated the syphilis surveillance system in Thailand through a case study of Mae Sot Hospital.

Mae Sot District, Tak Province, is situated in the northwest region of Thailand. The total area accounts for about 1,986 km^2 with 119,835 Thai citizens and more than 100,000 migrants. Mae Sot is the largest urban center along the Thailand-Myanmar border and has been rapidly changing from a small border town to a large special economic zone.

As currently the rise of syphilis cases is one of the key public health concerns nationwide and this situation is also pronounced in Mae Sot District, the evaluation of the syphilis surveillance system in Mae Sot Hospital is likely to be beneficial to identify potential gaps in the service and reporting system. Also, it is hoped that the study can serve as an example for other health facilities in Thailand how the evaluation of chronic communicable diseases such as syphilis can be performed.

Thus, the objectives of the evaluation were to describe the usefulness of the syphilis surveillance system and evaluate its performance at Mae Sot Hospital via selected quantitative and qualitative attributes and provide practical recommendations to improve the surveillance system for the hospital.

Methods

Study Design

This study applied a cross sectional design. Both quantitative and qualitative attributes were assessed. The evaluation was divided into two elements: (i) description of the operating process of the syphilis surveillance system, and (ii) evaluation of the performance of the system and its usefulness.

Study Site

The evaluation of the syphilis surveillance system was conducted in Mae Sot Hospital, Mae Sot District, Tak Province, Thailand.

Study Period

The field study was performed during 13 to17 Aug 2019. The period of interest ranged from 1 Jan 2018 to 31 Dec 2018.

Data Collection Techniques and Participants

System description

A qualitative approach was used in this element. In-depth interviews and observations were the main data collection techniques. The research team interviewed the hospital staff involved with the reporting system and observed their work process. The interviewees were asked to describe the syphilis surveillance system, with a focus on its purpose, the flow of data, the resources used to operate the system, and the usefulness of the system.

Evaluation of the performance of the surveillance system and its usefulness

To assess the system performance, the research team focused on the following attributes: (i) quantitative attributes, comprising sensitivity (proportion of the reported true cases to the total true cases), positive predictive value(PPV) (proportion of the cases meeting case definition to the total reported cases), completeness (percentage completion of variables

entered in the reporting system), validity (number of matched medical records among the reported true cases),timeliness (duration from date of diagnosis to date of reporting; using a one-day window as a cut-off) and representativeness (comparing the number of cases meeting case definition and reported cases); and (ii) qualitative attributes, comprising simplicity, acceptability, stability, and flexibility. The system description and the usefulness were asked alongside the interviews for qualitative attributes.

For quantitative attributes, medical records were reviewed from the following data sources (i) HOSxP (according to the 10th version of International statistical classification of diseases [ICD10]—such as congenital syphilis (A50.0-A50.9), unspecified late syphilis to neurosyphilis (A52.0-A52.3), other symptomatic late syphilis to late syphilis, unspecified (A52.7-A52.9), latent syphilis, unspecified as early or late (A53.0) and unspecified syphilis(A53.9), (ii) blood bank, (iii) antenatal care (ANC) unit, (iv) sexually transmitted disease and HIV (STI/HIV) clinic, (v) migrant health screening unit, (vi) serology laboratory logbook and (vii) pharmacy unit. Additionally, the research term reviewed data of newborns from mothers with syphilis at the labour room and paediatric unit; and reviewed data of the mothers of congenital syphilis cases in the HOSxP.

Table 1. **Details of the respondents involved in the interviews**

Position
1. Deputy director
2. Infectious disease medical specialist
3. Paediatrician
4. Medical obstetrician/gynaecologist
5. Epidemiologist
6. Epidemiology unit officer
7. Labour room nurse
8. Health screening unit nurse
9. Antenatal care nurse
10. Gynaecology unit nurse
11. Sexually transmitted disease (STI) clinic nurse
12. Serology laboratory technician
13. Blood blank officer
14. Information and technology (IT) officer
15. IT coder (1)
16. IT coder (2)

All data were coded into data extraction forms. Descriptive statistics were applied on quantitative data. The case definitions of syphilis were adopted from the Centers for Disease Control and Prevention (CDC) guidelines with slight modifications to match with evaluation process.

For qualitative attributes, in-depth interviews using semi-structured questionnaires were conducted on 16 respondents. The qualitative data were analysed by content analysis method. Details of the respondents are presented in Table 1.

The research team then performed an additional analysis to explore the demographic features of syphilis cases in Mae Sot Hospital. This included the distribution of cases by residential address and percentage of each stage of syphilis (primary,

secondary, latent and congenital). Unreported cases were traced back to the service sites and were identified for their characteristics. An additional search for syphilis from other ICD10 diagnoses that can mimic syphilis signs and symptoms, such as gonococcal infections (A54.0 – A54.9), chlamydial lymphogranuloma (A55), and other chlamydial infections (A56.0-A56.4, A56.8) was done.

Results

System Description

The data from the antenatal care (ANC) clinic, health screening unit, obstetric and gynaecological unit, paediatric unit, STI/HIV unit, inpatient department, outpatient department and labour room were directly reported to the hospital information system (HOSxP). All records from these data sources were also transferred to the pharmacy unit for prescribing the treatments. Laboratory results from all service units in the hospital except the blood bank were sent to the laboratory information system.

The data from HOSxP were sent to the statistical group of the epidemiological unit within three days. Then, within one week, the epidemiology unit would code these data into Thailand's National Disease Surveillance System (henceforth R506) at the Epidemiology Division and Tak Provincial Health Office.
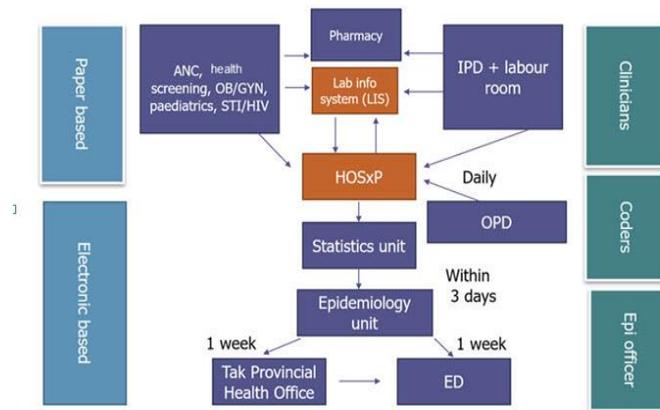
Figure 1. Description of data flow of the syphilis surveillance system at Mae Sot Hospital, 2018

Quantitative Attributes

The research team found that with all datasets combined and after deleting duplicates, a total of 375 cases met the inclusion criteria of which 175 met the case definition. Among these cases, 118 were reported to R506. Table 2 shows a summary of all syphilis cases at the hospital.

Sensitivity

The sensitivity of syphilis reporting system at Mae Sot Hospital was 67.4% (118/175).

Table 2. Case summary of syphilis at Mae Sot Hospital, 1 Jan 2018 to 31 Dec 2018

	Met case definition	Did not meet case definition	Total
Reported in R506	118 (a)	0 (b)	118 (a+b)
Not reported in R506	57 (c)	200 (d)	257 (c+d)
Total	175 (a+c)	200 (b+d)	375 (a+b+c+d)

Positive Predictive Value

The positive predictive value of syphilis reporting system at Mae Sot Hospital was 100% (118/118).

Completeness

Completeness for age, sex, marital status, ICD10, nationality and occupation were reviewed. All reported cases had complete information on these variables.

Timeliness

Timeliness was measured by duration of time between date of diagnosis and date of reporting to R506. There were 111 from 118 cases (94.1%) that were reported to the R506 within a one-day window.

Validity

Sex, marital status, and diagnosis were all correctly coded. Age was incorrectly coded in one record (46 years in the R506 *versus* 34 years in HOSxP) representing an accuracy of 99.2%. Nationality was incorrectly coded in 21 records giving an accuracy of 82.2%.

Representativeness

Sex and age in the R506 represented the sex and age information in HOSxP very well. A slight margin was observed between the two datasets. However, non-Thai nationality in the R506 under-represented the true cases by about 11.0% (Table 3).

Table 3. Representativeness of variables in the R506 compared to HOSxPat Mae Sot Hospital, 1 Jan 2018 to 31 Dec 2018

Characteristic		HOSxP	R506
Mean age (standard deviation)		31.0 (12.0)	31.2 (10.3)
Sex (n, %)	Male	93 (53.2)	65 (54.6)
	Female	82 (46.9)	54 (45.4)
Nationality (n, %)	Thai	19 (10.9)	26 (21.8)
	Non-Thai	156 (89.1)	93 (78.2)

Table 4. Summary of content analysis for qualitative attributes

Attribute	Positive	Negative	Neutral	Not applicable
	n (%)	n (%)	n (%)	n (%)
Simplicity	10 (62.5)	1 (6.3)	4 (25.0)	1 (6.3)
Acceptability	11 (68.8)	1 (6.3)	4 (25.0)	0
Stability	9 (56.3)	1 (6.3)	4 (25.0)	2 (12.5)
Simplicity	10 (62.5)	1 (6.3)	4 (25.0)	1 (6.3)
Flexibility	3 (18.8)	4 (25.0)	3 (18.8)	6 (37.5)
Usefulness	13 (81.3)	0	2 (12.5)	1 (6.3)

Qualitative Attributes

The summary of results from content analysis is demonstrated in Table 4.

Simplicity

About 60% of the interviewees mentioned that it was not too difficult to operate the system. One of respondents reported that it was not easy for the system to provide disease information in non-Thais due to a lack of a unique identification number in some cases. Nearly a quarter of the interviewees said they were not involved in the all aspects of the system and were not certain about its simplicity.

Acceptability

About 70% of the interviewees said that they accepted the system, though there were some operational difficulties. About a quarter of the respondents showed neutral opinions towards the system as they were not aware of the reporting system.

"I don't know about the system. I just examine and diagnose and treat the patients. I need specific guidelines, especially for non-Thai patients because the current guideline is mainly applicable for Thai patients." Medical obstetrician/gynaecologist

Stability

More than half of the respondents reported that the system was stable and easy to maintain because they had backup plans such as auxiliary manpower and contingency data storage on a cloud server. This system was also financially supported from the regular budget. One respondent mentioned that if there were more training sessions and more staff, the system could be improved, particularly for tracing patients lost to follow up. About 40% of the interviewees responded that they were not involved in the whole system and were not certain about its stability.

"The system is able to run smoothly. It is operated by a three-person team in which they can use the regular operating budget. Additional budget to maintain the system is not necessary." Deputy director of Mae Sot Hospital

Flexibility

Approximately one fifth of the respondents said that the system was flexible. Any change in the case definition would not cause significant impact on the reporting system. However, about a quarter of the respondents expressed some doubts as to the flexibility of the system as it could not be integrated with other reporting systems and this issue was linked with the patients' confidentiality.

"I rarely merge the syphilis reporting system [with others]as this links to patients' confidentiality and commercial issues." Blood bank officer

Usefulness

The majority of respondents mentioned that the system was useful. Information from the system was beneficial for case management, including follow-up planning.
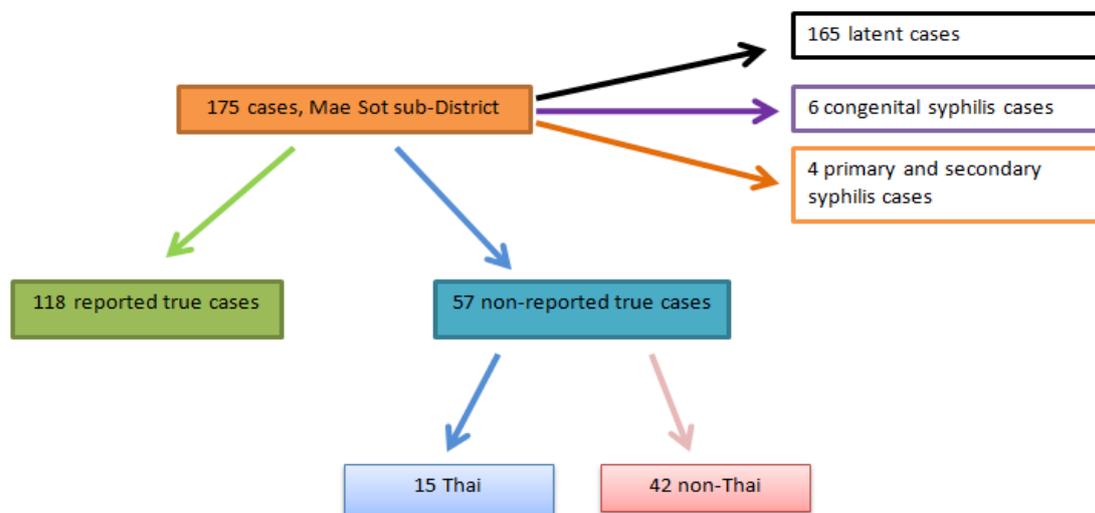

Figure 2. Diagram of detailed investigation on syphilis cases at Mae Sot Hospital, 13 to 16 August 2019

Additional Analysis

The evaluation team further investigated characteristics of the syphilis cases in Mae Sot Hospital. The cases were divided into sub-districts and nationalities. There were 19 Thais and 156 non-Thais among the 175 cases. As shown in Table 5 Mae Sot Sub-district had the largest prevalence of syphilis (for both Thais and non-Thais) compared to other areas.

After reviewing all 175 syphilis cases, 165 were latent (94.3%), 6 congenital (3.5%) and 4 were a combination of primary and secondary (2.3%). Among the six congenital cases, one was non-Thai whose maternal treatment was not available for review. For the other five cases, two appeared in the R506 while the other three did not.

Among the 57 cases meeting the definition of syphilis but not reported in the R506 (c in Table 2), 15 were Thai nationality while the other 42 were migrants. Among these, 11 did not receive any treatment (Thais = 3 and non-Thais = 8). Most of the non-reported cases were from the health screening unit. Incomplete ICD10 coding was noted in most non-reported cases.

The research team further examined the reports that originated from the blood bank unit. There were 33 cases (Thais = 14 and non-Thais = 22) that showed reactive Treponema Pallidum Haemagglutination Assay (TPHA), which suggested that these cases had a previous history of syphilis. All 14 of the Thai cases resided in Mae Sot District and eight tested weakly positive on the Venereal Disease Research Laboratory

(VDRL) test. Three cases had a high titer of VDRL (>1:8).

Table 5. Case distribution stratified by sub-district and nationality

Sub-district	Thai (n = 19) n (%)	Non-Thai (n = 156) n (%)
Mae Sot	7 (36.7)	45 (28.8)
Tha Sai Luat	2 (11.1)	38 (24.3)
Mae Pa	2 (11.1)	16 (10.2)
Mae Ku	0 (0.0)	15 (9.6)
Phra That PhaDaeng	1 (3.1)	13 (8.3)
Mae Kasa	2 (11.1)	11 (7.0)
Mae Tao	0 (0.0)	10 (6.4)
Mahawan	0 (0.0)	2 (1.3)
Phawo	2 (11.1)	1 (0.9)
Dan Mae La Mao	3 (15.8)	0 (0.0)
Unknown	0 (0.0)	5 (3.2)

From the additional search for potential syphilis cases from other ICD10 diagnoses 97 suspected cases were identified, of which two met the definition of syphilis based on clinical findings. As shown in Table 6, both of these cases were recoded as gonococcal infection (A54).

Table 5. Additional search for syphilis from syphilis mimicking diagnoses

	Gonorrhea	Chancroid	Rash & others	Total
Did not meet case definition of syphilis	12	3	80	95
Meet case definition of syphilis*	2	0	0	2
Total	14	3	80	97

Note: *One suspected primary syphilis and one suspected secondary syphilis

Discussion

A surveillance system evaluation is a critical and useful action to ensure that diseases with public health importance are appropriately monitored. The overall sensitivity of the syphilis surveillance system at Mae Sot Hospital was 67.4% and the PPV was 100%. A high PPV suggests that the system did not lead to unnecessary resources used. The timeliness of the surveillance system at Mae Sot Hospital was 94.1%, denoting a timely management of disease prevention and control. This is likely due to the application of an electronic-based system that facilitates timely submission of data. This finding is consistent with an earlier study, which evaluated the Syndromic Surveillance System in six states in the US and found that the system provided near-real time data submission with a slight delay occurring because of the automated processing time for network transmission.[6]

The syphilis surveillance system at Mae Sot Hospital contained high quality data. Apart from the patient's nationality, the degree of data validity and completeness was high. For qualitative attributes, the system was useful, acceptable, simple and stable. This result is similar to a finding from an earlier study that evaluated the malaria surveillance system in Kanchanaburi Province.[7] This suggests that the health sector in Thailand has performed well in operating surveillance systems on key diseases that may cause public health threats, such as malaria and syphilis.

The review of cases that might mimic syphilis signs and symptoms found that the risk history (for example sexual contact) and details of lesions (for example ulcer characteristics) were not well documented in the medical charts. This created some difficulties in judging whether the patient met case definition of syphilis. This barrier also hampered the research team in differentiating types of syphilis with the data in hand.

There were many unreported suspected cases from the blood bank registers. This was due to a lack of communication between blood bank staff and those responsible for the hospital reporting system and a lack of mechanism of the blood bank staff to encourage suspected donors return to the hospital to receive further blood testing. The latter is in fact the interaction between staff from the blood bank unit, the Red Cross and donors. However, the former is something that can be improvedby strengthening the communication amongst the hospital subunits.

The proportion of unreported syphilis cases was higher amongst non-Thais than Thais. This is likely due to the routine health screening system for non-Thais. Migrant workers in Thailand are neededto undertake health screening as a condition to obtain a work

permit. Yet, in practice, many migrants (and employers of migrants) did not wait for the results of the screening. Sometimes the work permit issuance system was relaxed by allowing migrants to show only the evidence of undertaking health screening (such as receipt or medical bill) to fulfil the work permit condition. A better linkage of data between the health screening unit and the STI/HIV clinic is required to ensure better surveillance and treatment coverage for non-Thai populations.

For congenital syphilis, the pitfall of non-reporting was incomplete diagnosis where the newborns were recorded as a normal delivery without specifying congenital syphilis as a comorbidity. One study in northeastern Brazil found that about 39.0% of congenital syphilis deaths were not reported into the surveillance system.[8] Another study in a low-incidence state in the US showed that about one third of newborns with probable congenital syphilis did not receive treatment.[9]

The blood bank data were separated from the HOSxP data by default. This is because normally the blood bank unit submitted the blood samples of donors to the Red Cross. Given positive results, the Red Cross would report the results back to the blood bank unit. The blood bank unit then contacted each individual donor by invitation letter. However, it solely depended on each individual whether he/she wished to return to the hospital for further checking.

This study faced some limitations. First, as our study focused on only one hospital and so is not representative of the whole country. Second, the research team did not explore the functions of private health facilities or non-governmental organizations. Third, the case definitions stipulated by the CDC and the R506 exhibited a slight difference. Therefore, if the readers wish to contrast this study's findings with others that applied a different case definition, the finding interpretation should be made with caution.

Conclusions

The sensitivity of reporting syphilis cases into Thailand's national notifiable disease surveillance reporting system in Mae Sot Hospital in 2018 was approximately 67% while the PPV was 100%. The data quality of reporting reached almost 100% in all variables. The reported data represented the true cases very well in terms of sex and age distribution, but not in terms of nationality. The majority of participants found the reporting system useful, acceptable, simple and stable. Incomplete diagnosis

and coding were the key concerns accounting for low sensitivity, and cooperation amongst within-hospital units (blood bank, sexually transmitted infection [STI]/HIV clinic, and antenatal care clinic) for better capture syphilis cases in hospital is recommended.

Public Health Recommendations

To enhance the sensitivity of the syphilis surveillance system in Mae Sot Hospital, the following actions are proposed.

- The physicians (or in-charge nurses, especially in the ANC and STI/HIV clinic) should be encouraged to document the diagnosis of syphilis more clearly (not only in the principal diagnosis but also as a co-morbidity).

- The coders should be reminded to thoroughly search for syphilis, both in the principal diagnosis and co-morbidity.

- The officers at the health screening unit should regularly check if the syphilis cases visit the STI/HIV clinic.

- The epidemiology unit should routinely conduct an in-house audit by including the engagement of relevant units such as pharmacy, ANC clinic and labour room.

Apart from enhancing the sensitivity of reporting, the hospital may consider enhancing the treatment of syphilis by implementing the following proposals.

- Requesting the blood bank staff to notify the STI/HIV clinic for cases testing positive for VDRL/TPHA in the donors (in addition to notifying individual donors by letters).

- Asking staff at the ANC clinic to notify the STI clinic whenever a case tests positive for VDRL/TPHA (either in pregnant women themselves or her partners);

- All patients presenting with STI signs and symptoms should have a VDRL and TPHA test.

Acknowledgements

Suggested Citation

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surveillance system at Mae Sot Hospital, Mae Sot, Tak Province, Thailand in 2018, conducted during 13-16 Aug 2019. OSIR. 2020 Dec; 12(4):144-152.

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Harnessing Momentum in Driving Vaccine Security and Self Reliance in Thailand through the Association of Southeast Asian Nations

Worawit Boonyatistan[1]*, Aniqa Islam Marshall[2], Rapeepong Suphanchaimat[2,3], Attaya Limwattanayingyong[1], Nakorn Premsri[1]

1 National Vaccine Institute, Ministry of Public Health, Thailand

2 International Health Policy Program, Ministry of Public Health, Thailand

3 Division of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand

*Corresponding author, email address: worawit.b@nvi.go.th

Abstract

Vaccines are one of the most cost-effective public health interventions for the prevention and control of many communicable diseases. Therefore, vaccine security and self-reliance are important issues for national security, as shortages and stock-outs of vaccines pose the risk of disease resurgence and outbreaks, making a country prone to large-scale epidemics. Thailand has been working to ensure availability, accessibility and utilization of quality vaccines by driving the 'vaccine security agenda' both nationally and regionally for years, through the ASEAN Vaccine Security and Self-Reliance (AVSSR) Initiative. This paper describes the progress and achievements of the quest towards vaccine security and self-reliance in Thailand and in ASEAN. The Initiative provides an effective platform to increase collaboration amongst nations in the region with an aim to ensure sustainable supply of quality vaccines and discusses the on-going challenges that need to be addressed.

Keywords: vaccine, vaccine security, Thailand

Introduction

Vaccines are universally recognized as one of the most cost-effective public health interventions for the prevention and control of infectious diseases. Interruption of the continuous use of vaccines, even short-term, creates a risk of vaccine preventable disease (VPD) resurgence and outbreaks, which may ultimately lead to large-scale epidemics.[1] Vaccine security is defined by the United Nations Children's Fund (UNICEF) as *'the timely, sustained, uninterrupted supply of affordable vaccines of assured quality'* to ensure adequate public health protection in a country.[2,3] While "vaccine self-reliance" refers to the ability of the country and/or region to optimally ensure sufficient vaccines for use in routine immunization and emergency situations, based on its own capacities and resources and without needing much help from outside.

Vaccine shortages have been attributed to numerous factors including procurement challenges due to constraints in vaccine supply, production problems and vaccine market interruption (for instance, manufacturing companies and/or products leaving the market, and insufficiency of manufacturing companies to produce products that meet the consumer demand).[4]

Vaccine insecurity is a critical challenge faced by many countries. Low and middle income countries (LMICs) are most likely to be affected by the incidental stock-outs and shortages of vaccines (both vaccines used in basic immunization programs and those used for outbreak control during emergency situations).[1] This issue is not only a concern in the field of public health but also a matter of national economy and social security.[5]
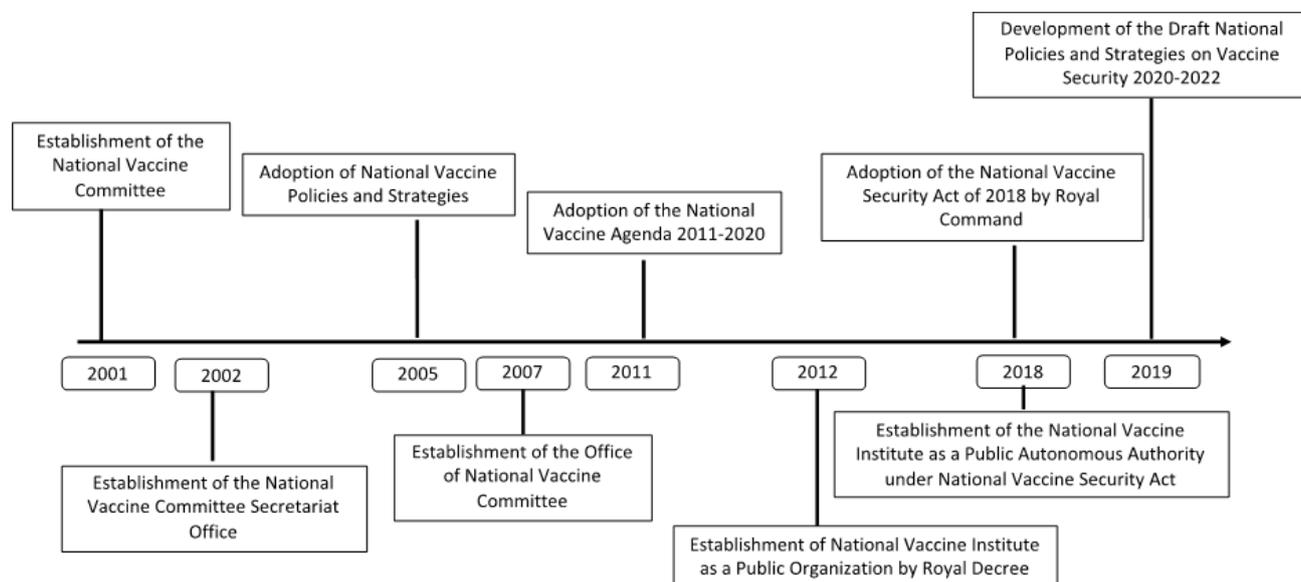
Figure 1. Chronological development of National Vaccine Institute from 2001 to 2019

In this regard, Thailand has put huge effort into ensuring the availability, accessibility and utilization of quality vaccines, through a number of policies and strategies. Thailand also serves as a focal point in driving the vaccine security agenda in the Southeast Asian region, largely through the Association of Southeast Asian Nations (ASEAN), which acts as a key platform for regional collaboration.

ASEAN is a platform for countries to share and learn on the best practices, which has the potential to lead to mutual collaborations in order to achieve the ultimate goal of Vaccine Security and Self-Reliance. This paper therefore aims to describe the progress and achievements of the quest towards vaccine security in Thailand and in ASEAN. It is hoped that the ASEAN Leader Declaration on Vaccine Security and Self-Reliance can be implemented into real actions and the lessons learned from Thailand can be used as useful inputs for other countries/regions where the vaccine security agenda is on the spotlight.

Historical Evolution of Vaccine Security in Thailand

The quest towards vaccine security in Thailand began about two decades ago. One of the most important cornerstones was the establishment of the National Vaccine Committee (NVC) in 2001. In the following year, the National Vaccine Committee Secretariat Office (NVCO) was formed under the Department of Disease Control to steer the direction of vaccine security policies. (Figure 1)

However, the progress of implementation was low. This was partly due to the limited capacity and authoritative power of the NVCO. To this end, the

National Vaccine Institute (NVI) was established in 2012 as a public organization established under the Royal Decree. The organization is mandated to ensure equitable access to safe quality vaccines in Thailand for both routine use and emergency responses. In 2018, under the National Vaccine Security Act (B.E.2561), NVI was reaffirmed as a public autonomous authority, with a legal mechanism to enforce and support national policies and strategies on vaccine security in close collaboration with relevant agencies and partners both in and outside Thailand.[6] (Figure 2)

Despite significant progress at the policy level, numerous implementation challenges still remain, and vaccine-related problems have continued to take place from time to time. These include the mismatch of demand and supply of vaccines. On the supply side, vaccines are at times inadequate due to various reasons such as limited global production capacity of some vaccines, consolidated vaccine market, orphan vaccines (Vaccines for rare infectious diseases which may be important for critical areas, but are often not commercially manufactured due to limited pharmaceutical profitability), regulatory and trade barriers, and the standard requirements throughout the vaccine development cycle. At the same time, vaccine demand is increasing due to pandemic threats, emergence of VPDs, global elimination/eradication programs and increased population which entail increased demand for vaccines throughout the life course. Thus, the NVI alone may not be able to bring the country towards vaccine security. Concerted efforts from all stakeholders, both public and private sectors, national and international partners, are indispensable.
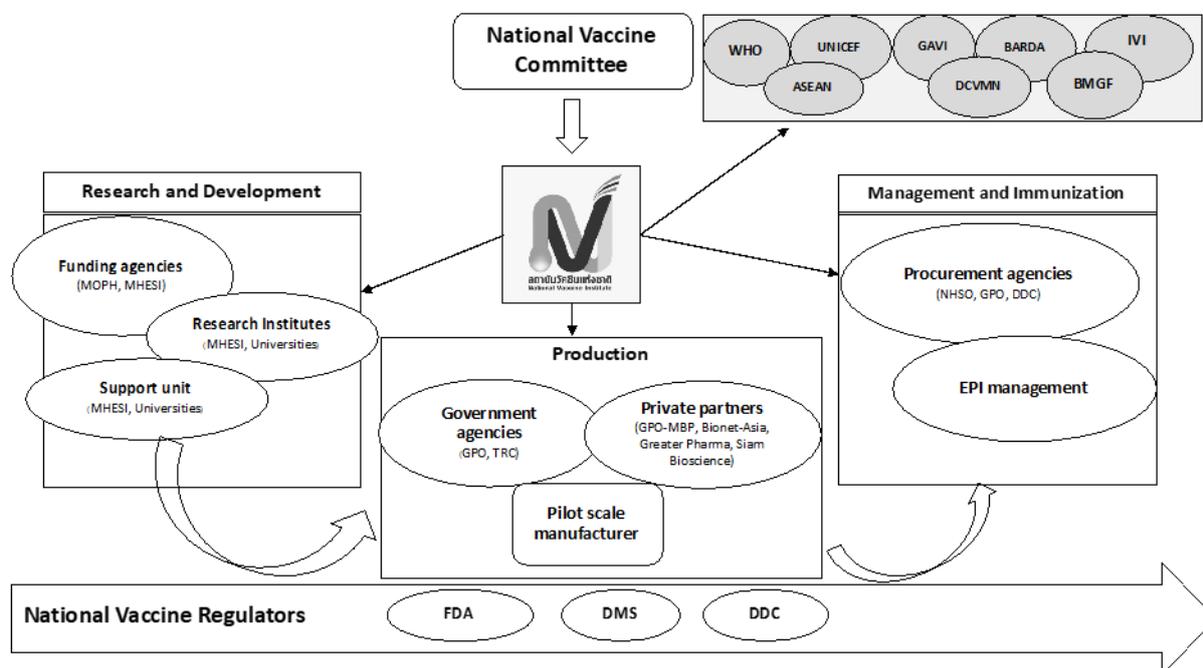
Figure 2. Relationship between NVI and potential partners concerning vaccine security in Thailand

Note: ASEAN: Association of Southeast Asian Nations, BARDA: Biomedical Advanced Research and Development Authority, BMGF: Bill & Melinda Gates Foundation, DCVMN: Developing Countries Vaccine Manufacturers Network, DDC: Department of Disease Control, DMS: Department of Medical Science, EPI: Expanded Programme on Immunization, FDA: Food and Drug Administration, GAVI: Global Alliance for Vaccines and Immunizations, GPO: Government Pharmaceutical Organization, GPO-MBP: Government Pharmaceutical Organization-Merieux Biological Products Co.,Ltd, IVI: International Vaccine Institute, MOPH: Ministry of Public Health, MHESI: Ministry of Higher Education Science Research and Innovation, NHSO: National Health Security Office, TRC: Thai Red Cross Society, UNICEF: United Nations Children's Fund, WHO: World Health Organization

Initiating A Regional Initiative on Vaccine Security and Self-Reliance of Vaccines

Recognizing the importance and necessity of regional collaborations to achieve vaccine security, in 2014, NVI worked closely with key partners to bring the issue of vaccine security and vaccine self-reliance to a regional health platform. With support from the World Health Organization (WHO), NVI brought together key stakeholders in the Southeast Asian region as well as international academics and international developmental partners to attend the workshops, 'Collaboration Initiatives for Regional Vaccine Security and Self-Reliance' held in 2014 and 2015.[7] The workshops aimed to identify common issues and interest amongst diverse countries in the region and ensure sufficient supply of affordable quality vaccines at both national and regional levels.[7] Following the official establishment of the ASEAN Community in 2015, the NVI proposed vaccine security as an agenda of regional importance to the Senior Officials Meeting on Health Development (SOMHD) in 2015 and the ASEAN Health Minister Meeting (AHMM) in 2016. This led to the adoption of the ASEAN Vaccine Security and Self-Reliance (AVSSR) Initiative in the ASEAN Health Priority Issue on Strengthening Health Systems and Access to Care' where Thailand served as the lead country.

In order to inform the development of regional strategies and actions on vaccine security, the ASEAN Vaccine Baseline Survey (AVBS) was conducted by Thailand in collaboration with ASEAN Member States in 2017 as part of the ASEAN Health Work Plan to assess the current vaccine situation and capacity of ASEAN Member States.[8] Through self-reported questionnaires, key informant interviews and study visits, the AVBS identified each ASEAN Member State's capacity on vaccine research, vaccine development and production, mechanisms for vaccine procurement and management as well as the similarities and challenges of vaccination policies in the region. The results of the AVBS found that the region has existing policies, strategies, infrastructure and capacities in driving vaccine security, however, there were still gaps in regional collaboration, regional vaccine procurement and stockpiling, knowledge sharing, and technology transfers for vaccine research, development and production.[8] The region has already been successful in producing vaccines, as presented in Table 1, and has substantial potential for increased vaccine production, especially for vaccines that are aligned with the National Immunization Programs and WHO guidelines. The resources and infrastructure available in most member states provide a strong basis for increased

contribution and collaboration from all AMSs to accelerate vaccine development and production in the region.

Moreover, in light of the partnership with ASEAN Member States and the ASEAN Secretariat, the NVI developed the ASEAN Leader's Declaration (ALD) on Vaccine Security and Self-Reliance in 2018. The ALD was further endorsed in the 35th ASEAN Summit in Bangkok, in November 2019. The Declaration explicitly shows a strong political commitment from the Governments of all ASEAN Member States, a crucial foundation in driving regional vaccine security.[9] Following the ALD endorsement, all ASEAN Member States concurrently agreed on the 'Regional Strategic and Action Plan on AVSSR', 2021-2025. The Plan aims to provide a framework for increased collaboration, engagement, and integration among ASEAN Member States and relevant international development partners to work together on Vaccine security and self-reliance.

Opportunities, Remaining Challenges and the Way Forward

Despite commitments from the Governments of all ASEAN Member States, there are opportunities and challenges to implement the AVSSR Initiative as shown in Table 2.

In the context of ASEAN, the most challenging issues are the variation of its economic, political and social systems, the multi-step and time-consuming decision mechanisms and limited capacities of the secretariat. However, at the same time, "ASEAN ways" can be considered as opportunities, the non-interference in domestic affairs and non-legal binding engagement and voluntarism principle provides flexibility for each country to move on its interest and allows other countries to work on their own priorities and own pace.

Table 1. Variability of vaccine manufacturing and standards among selected ASEAN Member States

Country	Manufacturer	Vaccine Products		Standard
Myanmar	Yarthargvi	-Hepatitis B		GMP
	Insein	-TT		
Vietnam	VABIOTECH	-Hepatitis B, -Japanese encephalitis	-Cholera -Hepatitis A	WHO-GMP
	POLYVAC	-bOPV -Rotavirus	-Measles -Measles, Rubella	
	IVAC	-BCG -DTwP	-TT, Td	
	DAVAC	-Typhoid -Hepatitis B	-Rabies	
Indonesia	BioFarma	-BCG	-Seasonal Flu	GMP-PIC/S
		-Hepatitis B -Measles -OPV -DTwP -DTwP-HB	-TT -DT, dT -DTwP-HB-Hib	WHO-PQ
Thailand	BioNet-Asia	-Acellular Pertussis (aP) -Tetanus Diphtheria Acellular Pertussis (TdaP)		GMP-PIC/S
	QSMI	-Rabies -BCG		
	GPO-MBP	-Hepatitis B -Seasonal Influenza -Rabies -Live Recombinant Japanese encephalitis (LAJE)		
	GPO	-Avian Influenza (H5N2) -Pandemic Influenza (EUA)		WHO-GMP

Note: IVA: Institute of Vaccines and Medical Biologicals, DAVAC: Dalat Pasteur Vaccines Company Limited, QSMI: Queen Saovabha Memorial Institute, GPO: Government Pharmaceutical Organization, GPO-MBP: Government Pharmaceutical Organization-Meraux Biological Products Co.,LTD., GMP: Good Manufacturing Practices, GMP-PIC/S: GMP- Pharmaceutical Inspection Co-operation Scheme, WHO-GMP: World Health Organization-Good Manufacturing Practices, WHO-PQ: World Health Organization-Prequalified

**Table 2. Opportunities and challenges in driving the AVSSR
(the ASEAN Vaccine Security and Self-Reliance)**

	Opportunities	Challenges
ASEAN context	▪ Large population, economy of scale and high Foreign Directed Investments ▪ Strategic geographic location with linking platforms with big economies (China, USA, Japan, South Korea, South-South collaboration) ▪ Joint visions on vaccine security and joint targets on national immunization programs	▪ Varying economic, political and social systems, geographical differences ▪ Varying developmental levels ▪ Maritime disputes on the South China Sea ▪ Diverging national priorities ▪ Different designs of health systems and immunization programs
ASEAN decision mechanisms and outputs	▪ Non-interference in domestic affair ▪ Non-legal binding engagement and voluntarism principles given more flexibility for each country to move on its interest and its own pace ▪ Plenty of non-binding high-level agreements	▪ Multi-step and time-consuming process ▪ Reaching decision through consensus ▪ Need for capacity on strengthening of the secretariat ▪ No concrete outputs/success
VSSR capacities	▪ Progress on the harmonization of the regulation ▪ Availability of vaccine production capacities in some countries	▪ Limited R&D capacities (conventional technologies)
Collaboration areas on VSSR	Common areas of interest ▪ Information sharing ▪ Capacity building ▪ Procurement and stockpiling	Areas of Conflict ▪ Competitive nature ▪ R&D ▪ Production

Although there are diverging national priorities and varying national health and immunization systems. There are still a number of mutual areas of interest for collaboration on vaccines in ASEAN including information sharing, capacity building, procurement and stockpiling. Therefore, ASEAN Member States can collaborate in good faith in these key areas through the AVSSR Initiative. These ventures can collectively build trust and bring the relationships of ASEAN countries to the next level.

Conclusion

Vaccine security has been a key issue which Thailand has been addressing in the last two decades. This is not only a matter of in-country public health concern, but also the issue on political spotlight in ASEAN. Thailand, through NVI, has pushed the vaccine security and self-reliance agenda forward through various strategies and mechanisms, especially the ASEAN platform. Despite the long journey towards vaccine security and self-reliance, Thailand has been successful in adopting the National Vaccine Security

Act and progressed in the efforts at a regional level through the endorsement of the ALD on AVSSR. Nevertheless, these achievements are not the end of the story as continued efforts are still needed to translate the intention into actions. The Regional Strategic and Action Plans on AVSSR will be a crucial instrument to implement the ALD. It will be jointly developed by ASEAN Member States taking into account both national priorities and issues of regional importance. Strengthening regional cooperation and building institutional capacity within the region are essential to ensure that all ASEAN Member states will not face vaccine stock-outs and shortages and achieve better access to vaccines both during times of emergency and for routine situations and at the same time minimizing over supplies and wastage of vaccine products.

Suggested Citation

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