Outbreak, Surveillance, Investigation & Response (OSIR) Journal
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Approaches to Prevent Influenza Transmission among New Conscripts in a Battalion during High Seasonality

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Abstract

On 1 Aug 2017, the Bureau of Epidemiology was notified that five conscripts from a single battalion unit in Chiang Mai Province presented with influenza-like illness (ILI) in two days. A joint investigation was performed to confirm the outbreak, describe the epidemiological characteristics, and identify the source of infection and risk factors. Active case finding was conducted, and either nasopharyngeal or throat swab from 11 patients were collected. Environment and activities in the unit were studied, and a retrospective cohort study was conducted. An influenza outbreak occurred in the new conscript unit during 17 Jul to 20 Aug 2017, with 40.6% attack rate. Major symptoms were fever (100%), cough (83.8%) and runny nose (75.0%). Out of 86 clinically diagnosed cases, 11 were laboratory confirmed. None developed pneumonia. Influenza A(H3N2) was identified in all 11 specimens tested by reverse transcription polymerase chain reaction. Basic reproductive number (R_0) among conscripts in the affected unit was 1.3 (95% CI = 1.24-1.38). Close contact with an ILI case was a significant risk factor for influenza infection (adjusted odds ratio = 3.56, 95% CI = 1.68-7.45). A strict protocol for daily screening and early isolation during the epidemic season could prevent influenza outbreaks in a military setting.

Keywords: influenza, outbreak, military, conscript

Introduction

Influenza A viruses belong to the *Orthomyxoviridae* family which comprises of seven genera: A, B, C and D, *Thogotovirus*, *Isavirus* and *Quaranfilvirus*. Currently, 18 hemagglutinin (HA) and 11 neuraminidase (NA) subtypes are identified for influenza A viruses. The common subtypes circulating among humans are A(H1N1) and A(H3N2).[1] The genetic reassortment influenza A(H1N1) virus emerged in 2009, which provoked the influenza pandemic on 11 Jun 2009.[2]

The influenza viruses can be transmitted from person-to-person mainly via respiratory droplets, direct contact and small aerosol particles. The average incubation period is two days (range 1-4 days[1], mean 1.4 days[3]). Some can transmit the virus as early as one day before the onset.[4] Most of the infected people develop fever with myalgia and upper respiratory symptoms such as cough. Only 1-2% progressed to severe pneumonia whereas 18-30% could be asymptomatic.[5,6]

Influenza infection exhibits an annual global attack rate of 5-10% in adults and 20-30% in children.[7] In Thailand, a national study from 2006 to 2011 revealed the average influenza-associated mortality rate as 4.3 per 100,000 population in non-pandemic years, and 2.4 per 100,000 population in 2009.[8]

On 1 Aug 2017, the Bureau of Epidemiology (BOE) received a notification from Chiang Mai provincial

health office that five conscripts from a single unit in a battalion were seeking treatment for influenza-like illness (ILI) at a military hospital on 30-31 Jul 2017. The staff from BOE, Office of Disease Prevention and Control 1, provincial heath office and the military hospital jointly conducted an investigation on 2-4 Aug 2017 to confirm the diagnosis and outbreak, describe the epidemiological characteristics, identify the origin and risk factors, and recommend control measures.

Methods

Influenza Situation in Chiang Mai Province

To identify the influenza outbreaks in Chiang Mai Province, information from the event-based surveillance system in BOE reported from 1 Jan to 1 Aug 2017 were reviewed.

Descriptive Epidemiology

Active case finding was conducted among soldiers in Battalion X from 2 to 4 Aug 2017 using three methods. The out-patient and in-patient medical records of soldiers from the battalion who visited the military hospital from 17 Jul till 4 Aug 2017 were reviewed using the international classification of diseases (ICD)-10 codes (J11.1, J00-06, J09-18, J20-22). Subsequently, commanders in the battalion announced and sought for soldiers with ILI symptoms during the same period. Meanwhile, the soldiers in the affected unit were investigated as well. Information was gathered using a self-administered semi-structured questionnaire.

A clinically diagnosed case of influenza infection was a soldier in Battalion X presented with fever (subjective or body temperature more than 37.8°C) with at least one of the symptoms: cough, sore throat, runny nose, headache, or myalgia between 17 Jul and 4 Aug 2017. A laboratory confirmed case was a clinically diagnosed case tested to have influenza virus in nasopharyngeal or throat swab by rapid test or reverse transcription polymerase chain reaction (RT-PCR).

Descriptive findings were presented in percent, median and interquartile range. Moreover, the basic reproductive number (R_0) was calculated using attack rates in R_0 package of R-program[9] during the exponential curve from 26 Jul to 1 Aug 2017.

In the simple SIR model, relation between R_0 and attack rate is in the form:

$R_0 = -\ln((1-AR)/S_0) / (AR -(1-S_0))$

where AR is the attack rate during the period from the first case to the epidemic peak and S_0 is the initial proportion of the population considered susceptible. The variance of R_0 was estimated using the delta method and the correction for incomplete susceptibility was based on the SIR model equations. Confidence interval (CI) was computed for the attack rates, considering the population size (CI(AR) = AR +/- 1.96*sqrt(AR*(1-AR)/n)), and thus, CI for the reproductive number was computed with this extreme values.[10]

Laboratory Testing

Clinical specimens were collected from 11 patients who had the onset date within four days. All 11 specimens were tested by both rapid test and RT-PCR. The rapid test kit was the immunochromatographic assay that can detect three subtypes of influenza: A, B, and/or H1N1.[11,12]

Regarding to RT-PCR testing, nine were sent to the Chiang Mai Laboratory Center for Epidemiology at Sansai Hospital and two specimens were tested at the Regional Medical Science Center for region 1.

Analytic Studies

A retrospective cohort study was conducted to identify the potential risk factors of influenza infection among the conscripts in the affected unit. The cohort was the conscripts who was in the affected unit during 17 Jul to 4 Aug 2017. The case definition was the same as in the descriptive study. ILI cases for contact history referred to persons with coughing, sneezing or fever within one week. Risk ratio and 95% confidence interval (CI) were calculated to determine strength of association. The potential risk factors to include in the analytic study were identified by reviewing the previous studies. Multiple logistic regression was employed to control possible confounders observed from the descriptive study, regardless of the univariate p-value.

Environmental Investigations

An environmental study was performed to assess the potential risk factors related to dormitories, canteen, water supply, garden and activities in the battalion. The infection prevention and control practice in the military hospital were observed as well.

Results

Influenza Situation in Chiang Mai Province

Chiang Mai is the second largest province in Thailand and situated at the northern part. Reviewing the national event-based surveillance data revealed six influenza outbreaks in institutional settings such as schools, battalions and prisons in Chiang Mai Province from 1 Jan to 1 Aug 2017. The attack rates ranged from 2.5% to 37.8%. The incidence of influenza in Chiang Mai during 2017 tended to be higher in monsoon and winter. Causative agents were two predominant subtypes of influenza: A(H3N2) and B. The median of

interval between disease onset and notification to BOE was seven days.

Descriptive Epidemiology

The event occurred at the new conscript unit of Battalion X located in Muang District, Chiang Mai Province, Thailand. There were total 213 conscripts, 13 trainers and nine commanders in the unit while all were male. The conscripts were divided into nine groups related to sleeping patterns and parade drill arrangements (Table 1).

Screening and interview coverage was 90.2% (212/235), which included 193 conscripts, 12 trainers and seven commanders. Of which, 86 clinically diagnosed cases of influenza were recorded, with the attack rate of 40.6%, while all of them were conscripts in the new conscript unit. Although 10.4% (9/86) were hospitalized, none developed pneumonia or died in this event.

The median age of the cases was 21 years old (range 20-25 years). In addition to fever in all cases, clinical manifestations were cough (83.8%), runny nose (75.0%), headache (66.3%), myalgia (53.8%), sore throat (46.3%) and dyspnea (23.8%).

The attack rate among conscripts who stayed in dormitory 1 was 43.3% (42/97) and that of dormitory 2 was 48.2% (40/83). There were 11 conscripts who did not stayed in the dormitories and four (36.4%) out of them became ill as well (Table 1).

The first case of this outbreak was a 21-year-old conscript and had not been vaccinated for influenza. He had fever, runny nose, myalgia, headache and conjunctivitis on 20 Jul 2017 and self-medicated. Nonetheless, he did not take oseltamivir. He had not been out of the camp or contacted with any ILI case within seven days before developing the symptoms. He sometimes shared drinking glasses with others.

The first case belonged to group 11 in dormitory 1 and subsequently, two conscripts in dormitory 1 developed the symptoms in two following days. The conscripts in dormitory 2 started to have the symptoms on 4th day after the first case's onset. The number of clinically diagnosed case climbed with the same magnitude in both dormitories since 27 Jul 2017, and the peak with 56 cases appeared on 1 Aug 2017 when the notification was delivered to Chiang Mai provincial health office (Figure 1).

Out of three (3.5%) conscripts reported to have influenza vaccination before the onset of illness, there was one (33.3%) clinically diagnosed case of influenza infection.

Table 1. Attack rate of influenza A(H3N2) infection among conscripts by residence in Battalion X, Chiang Mai Province, Thailand, 2017

Residence	Group Number	Total conscript	Screened	Clinically diagnosed case	Attack rate (%)
Dormitory 1	11, 12, 13, 31, half of 32	101	97	42	43.3
Dormitory 2	21, 22, 23, half of 32, 33	89	83	40	48.2
Others (convenient store, pavilion)	-	20	11	4	36.4

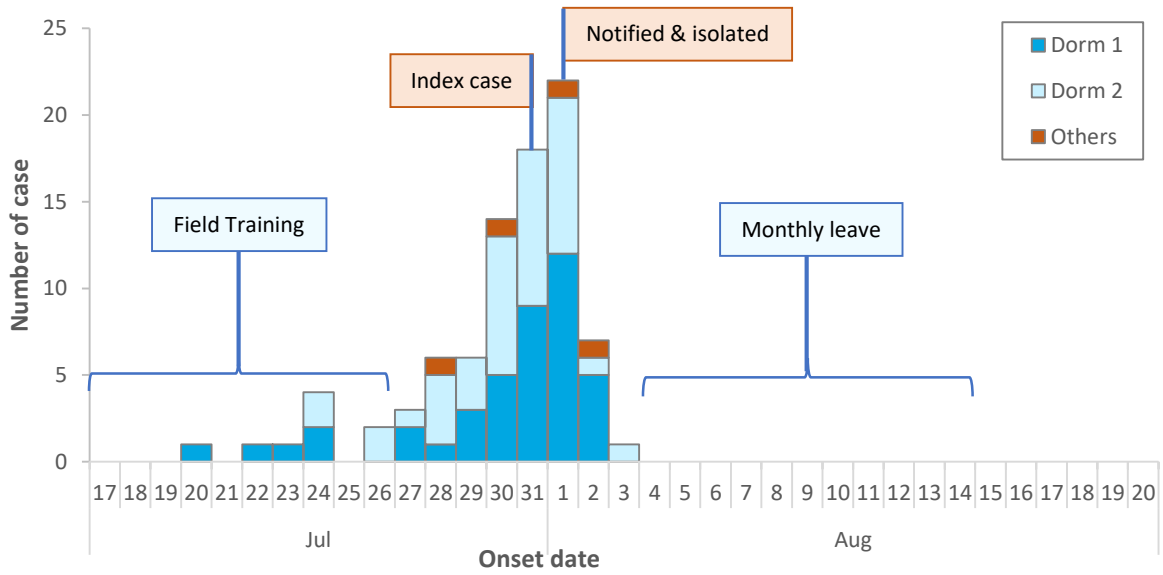

Figure 1. Clinically diagnosed and laboratory confirmed cases of influenza A(H3N2) infection among conscripts in Battalion X, Chiang Mai Province, Thailand, 12 Jul-20 Aug 2017 (n=86)

Laboratory Testing

Out of 11 nasopharyngeal and throat swabs collected, five of them were tested positive for influenza A virus by the rapid test and all 11 specimens were confirmed to have influenza A(H3N2) by RT-PCR. Regarding to 11 laboratory confirmed cases, their residency status showed seven (63.6%) in dormitory 1, two (18.2%) in dormitory 2 and two (18.2%) assigned in other places such as the convenient store and pavilion.

Analytic Studies

Nine reviewed risk factors were included in the retrospective cohort study, and exposed and non-exposed groups were compared for each factor. The univariate analysis showed three factors with high risk ratios for influenza infection, yet only one factor was significantly associated. The conscripts who had close contact with an ILI case were 2.19 times more likely to have influenza infection compared to the others (95% CI = 1.60-2.99) (Table 2).

To control the potential confounding factors, multiple logistic regression was employed and three potential risk factors were included. The conscripts who had close contact with an ILI case had adjusted odds 3.56 times (95% CI = 1.68-7.45) compared to the others (Table 3). R_0 among conscripts in the new conscript unit was 1.3 (95% CI=1.24 -1.38).

Environmental Investigations

During the environmental survey, two dormitories of the new conscript unit were located between the canteen and an open-air hall. The distance between conscripts' beds within the same group was 0.3 meter while that of each group was one meter. Trainers' beds were on the either end of the room, which were three meters apart from the conscripts' (Figures 2 and 3).

Table 2. Behavioral risk and risk ratio of influenza A(H3N2) infection among soldiers in Battalion X, Chiang Mai Province, Thailand, 2017

Exposure factor	Expose			Non-expose			Risk ratio	95% CI
	Total	case	Attack rate (%)	Total	case	Attack rate (%)		
Contact								
Contacted with ILI case (n=176)	64	45	70.3	112	36	32.1	2.19	1.60-2.99
Slept with leaning head against case (n=146)	7	5	71.4	139	62	44.6	1.60	0.97-2.65
Slept beside case (n=146)	24	9	37.5	122	58	47.5	0.79	0.46-1.37
Exercised near case (n=146)	58	27	46.6	88	40	45.5	1.02	0.71-1.47
Lined up beside case (n=146)	65	26	40.0	85	41	48.2	0.88	0.61-1.27
Dining								
Always or sometimes shared drinking glass (n=185)	156	68	43.6	29	14	48.3	0.90	0.60-1.40
Shared table with case (n=146)	56	24	42.9	90	43	47.8	0.90	0.62-1.30
Personal hygiene								
Always washed hand (n=185)	25	9	36.0	160	73	45.6	0.79	0.46-1.37
Flu history								
History of flu within last 12 months (n=158)	3	1	33.3	155	69	44.5	0.75	0.15-3.75

Table 3. Multiple logistic regression of behavioral risk factors and adjusted odds ratio in influenza A(H3N2) outbreak among soldiers from Battalion X, Chiang Mai Province, Thailand, 2017 (n=136)

Exposure factor	Adjusted odds ratio	95% CI
Close contact with influenza-like illness case (Y/N)	3.56	1.68-7.45
Slept with leaning head against case (Y/N)	2.77	0.47-16.28
Exercised near case (Y/N)	0.77	0.36-1.64

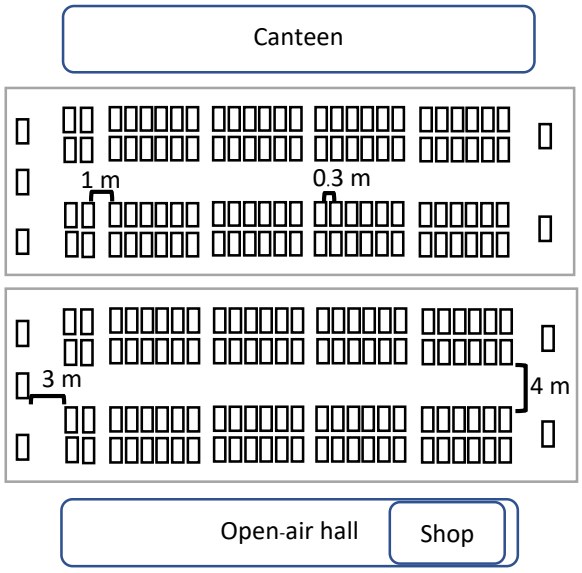

Figure 2. Crowded bed arrangement in the dormitory of the new conscript unit in Battalion X, Chiang Mai Province, Thailand, 2017

Figure 3. Dormitory in Battalion X, Chiang Mai Province, Thailand, 2017

Prior to meals, the conscripts had only a short time to wash their hands in a bucket before going inside the canteen. No wash-basin or soap was available in the camp. Although there were a drinking water container, some did not bring along with them and thus, shared the drinking glasses with others. The dining tables were 80 centimeters in width. Before having meals, they have to sit and sound off about 2-3 minutes at the dining tables.

Field training was the military practice took place on 10-26 Jul 2017. All conscripts were re-arranged into new seven groups according to the types of training activities. They stayed closely during the break times.

Screening and Response

During the recruitment process, no vaccination was provided to new conscripts in the battalion. In addition, there was no routine screening procedure for respiratory infections during the period of high influenza transmission. When a conscript got sick, he informed the responsible trainers who in turn asked for permission from the commander to seek treatment at the military hospital which located about five kilometers away. Occasionally, the permit was not granted due to compulsory activities such as the field training during 10-26 Jul 2017.

There was no designated isolation room for sick conscripts in the battalion or at the hospital. During this event, the hospital prepared two rooms, with about 9 m2, to isolate 4-5 ILI cases in each room, which was not sufficient for this outbreak. The event took 12 days from identification of the primary case (20 Jul 2017) to notification to the relevant sectors (1 Aug 2017).

Actions Taken

Health education on influenza transmission and preventive measures was provided to the soldiers in the affected unit. Extensive cleaning up in all units and daily cleaning of frequently hand-touched materials were performed to prevent fomite transmission. Beds in dormitories, activities and dining tables were set separately for sick conscripts. In the dormitories, all beds were rearranged by putting feet against each other instead of head-to-head.

There was a period of 10-day leave in the battalion on 4-14 August 2017. As the infectious period of influenza is 5-7 days from the onset date,[1] we suggested the camp not to allow those with ILI symptoms within five days to take leave. Nonetheless, challenges existed to follow the suggestion and since the sick conscripts could spread the infection to their family members, face masks and health education on influenza transmission were provided to them, emphasizing on frequent handwashing and practice of social distancing.

Discussion

An outbreak of influenza A(H3N2) in a military setting was confirmed among new conscripts in Battalion X, with 11 cases confirmed out of 86 clinically diagnosed cases during the period from 17 Jul to 4 Aug 2017. All the affected persons were conscripts. The possible risk factor of transmission identified in this outbreak was having close contact with a soldier with ILI symptoms.

The outbreak occurred in the second half of July, which followed the seasonal trend of the event-based influenza surveillance data in Chiang Mai during 2017. This was compatible with the seasonality trends in the influenza sentinel and ILI surveillance systems.[13]

The attack rate in this event was higher than previous outbreaks reported from other institutional settings in

Chiang Mai to the event-based surveillance system during 2017. However, it was similar to 44% of a military setting in Surat Thani Province during 2014[14] as well as 28-50% from other military bases in the country[15-16].

The attack rates among conscripts resided in dormitories were found to be high. However, trainers stayed in the dormitories and commanders did not become ill as they did not share the activities with sick conscripts. In contrast, conscripts who did not stay in the dormitories were also infected, which could be due to close contact during the activities, the field training, vowing and sounding off before having meals, or via fomites[17] such as door knobs and water jars. Close contact with an ILI case was the only significant risk factor in this study, which matched with the results from other prior studies[14,18].

Despite the battalion was populated with high number of conscripts, the R_0 resulted in this study was similar to the findings from other seasonal influenza outbreaks[14,19], implying that soldiers are ordinarily in better health condition and might prevent the extensive spread in this outbreak.

Influenza was one of the public health concerns in the military settings nationwide in Thailand[20] as well as in other military bases[21]. Previous investigations in Thailand recommended not to contact with cases, share drinking glasses or sleep nearby the cases.[14-17] However, those recommendations could not be followed due to the compulsory activities in the battalion.

Only about 3.5% of conscripts were found to have been vaccinated for influenza infection. In Thailand, the influenza vaccine under the national vaccination program is administered to merely high risk groups[22]. In addition, as no immunization program was provided in the battalion camp during the recruitment process, the majority of screened soldiers were assumed to be susceptible hosts. Thus, in addition to the routine recommendations on behavior and infrastructure setting, influenza vaccination should be considered to prevent influenza outbreak among new conscripts in parallel with other control measures. Evidences existed that implementation of influenza vaccination effectively can prevent morbidity among military population.[23] Influenza vaccine effectiveness in the previous studies were reported to be 30-70% in military settings.[24,25]

The routine screening was not performed for respiratory infections. Moreover, the sick conscripts were not granted for exemption of compulsory activities due to the military rules. Passive surveillance for influenza is crucial for not merely as a regular operation, it can convert into active surveillance to reduce the influenza spread in military settings.[26]

There was no isolation room in the camp and only two rooms were used to isolate ILI cases in the military hospital. This might affect the isolation measures, especially when a recovering patient was discharged from the hospital and sent back to the camp. Isolation is one of the effective methods to reduce influenza spread by preventing direct contact and airborne transmission.[27]

Furthermore, the index case was detected on the day of the epidemic peak. The compulsory activities in the military schedule such as field training might prevent sick soldiers to seek medical treatment, thereby causing delayed detection of outbreak by staff in the military hospital. In addition, asymptomatic or mild case might not be detected and this could hinder the identification of infection source in this outbreak, corresponding to the findings from other influenza outbreaks[14,28].

Limitations

The clinical specimens were tested by RT-PCR at two centers in order to compare the laboratory results. However, limited number of specimens were able to send to the Regional Medical Science Center due to high cost, about 90 USD for one specimen.

Evidences of prior vaccination was not be able to obtain due to unavailable vaccination records. In addition, some soldiers who had mild symptoms or recovered before the investigation were unlikely to disclose their illnesses so that they could take leave for 10 days. This could cause an information bias and affect the true magnitude of the outbreak.

Recommendations

The influenza vaccine should be administered to the new conscripts during the recruitment process, which could be supported by further studies on cost-effectiveness of vaccine and antiviral drug in institutional settings and other areas with high population density.

Instructions on daily ILI screening should be integrated into the routine training guideline in military medical departments during the epidemic seasons, especially rainy and winter seasons. In addition, as the guideline for heat stroke prevention by screening body temperature is available in the military settings of Thailand,[29] it could be adapted for fever screening during influenza epidemic season for early detection of influenza infection.

The isolation room should be planned in advanced and set up before the epidemic season in the battalion in order to promptly isolate the affected persons as well as managing the lodging space, dining tables and compulsory activities[30]. Handwashing basins with soap were suggested to set up in front of the canteen.

Communication channel between military camps and hospitals should be strengthened to avoid delayed notification and implement effective control measures. A strict protocol for influenza protection should be cooperated by hospital staff along with military staff. We also recommended the hospital staff to continue ILI screening from 2 to 4 Aug 2017 and until one week after the sick conscripts returned to the camp.

Acknowledgement

This outbreak was conducted under the activity of the International Field Epidemiology Training Program, Thailand, with tremendous support from public health authorities in relevant offices. The appreciation also goes towards the commanders, trainers and conscripts from the new conscript unit in Battalion X for responding to interview and providing the clinical samples.

We are also grateful to the director and staff from the military hospital, the provincial health office, the Office of Disease Control and Prevention region 1, the Regional Medical Science Center region 1, and the Chiang Mai Laboratory Center For Epidemiology at Sansai Hospital in assisting the investigation and providing logistic and laboratory support.

We also thank Dr. Fadzilah Kamaludin from Ministry of Health, Malaysia, for providing advice in development of this scientific manuscript.

All members of the investigation team were crucial and instrumental in collecting information, performing analyses and contributed in completion of the investigation.

Suggested Citation

Wonghirundecha T, Darasawang W, Tankasikit T, Sukprasan T, Baramee P, Boonrat P, et al. Approaches to prevent influenza transmission among new conscripts in a battalion during high seasonality. OSIR. 2018 Dec;11(4):14-22.

References

1. Heymann DL. Control of communicable disease manual. 18th ed. Washington DC: American Public Health Association, 2004.
2. World Health Organization. Pandemic influenza A(H1N1). 2011 Mar 1 [cited 2018 Jul 15]. <http://www.who.int/csr/resources/publications/swineflu/h1n1_donor_032011.pdf>.
3. Lessler J, Reich NG, Brookmeyer R, Perl TM, Nelson KE, Cummings DAT. Incubation periods of acute respiratory viral infections: a systematic review. Lancet Infect Dis. 2009 May;9(5):291-300.
4. Centers for Disease Control and Prevention. How flu spread. 2018 Aug 27 [cited 2018 Oct 10]. <https://www.cdc.gov/flu/about/disease/spread.htm>
5. Carrat F, Vergu E, Ferguson NM, Lemaitre M, Cauchemez S, Leach S, et al. Timelines of infection and disease in human influenza: a review of volunteer challenge studies. Am J Epidemiol. 2008 Apr 1;167(7):775-85. Epub 2008 Jan 29.
6. Suess T, Remschmidt C, Schink SB, Schweiger B, Heider A, Milde J, et al. Comparison of shedding characteristics of seasonal influenza virus (sub)types and influenza A(H1N1)pdm09; Germany, 2007-2011. PLoS One. 2012;7(12):e51653. Epub 2012 Dec 11.
7. World Health Organization. Seasonal influenza and influenza A(H1N1) [cited 2018 Jul 15]. <http://www.who.int/ith/diseases/si_iAh1n1/en/>.
8. Aungkulanon S, Cheng PY, Kusreesakul K, Bundhamcharoen K, Chittaganpitch M, Margaret M, et al. Influenza-associated mortality in Thailand, 2006-2011. Influenza Other Respir Viruses. 2015 Nov;9(6):298-304.
9. Bodelle P-Y, Obadia T. Estimation of R_0 and real-time reproduction number from epidemics. 2015 [cited 2018 Jul 15]. <https://cran.r-project.org/web/packages/R0/R0.pdf>.
10. Dietz K. The estimation of the basic reproduction number for infectious diseases. Stat Methods Med Res. 1993;2(1):23-41.
11. Mitamura K, Kawakami C, Shimizu H, Abe T, Konomi Y, Yasumi Y, et al. Evaluation of a new immunochromatographic assay for rapid identification of influenza A, B, and A(H1N1)2009 viruses. J Infect Chemother. 2013 Aug;19(4):633-8. Epub 2012 Dec 20.
12. Centers for Disease Control and Prevention. Information on rapid molecular assays, RT-

PCR, and other molecular assays for diagnosis of influenza virus infection. 2018 Feb 10 [cited 2018 Jul 15]. <https://www.cdc.gov/flu/professionals/diagnosis/molecular-assays.htm>.

13. Thailand. Bureau of Epidemiology. Department of Disease Control. Ministry of Public Health. Influenza surveillance data. Thai [cited 2018 Jun 15]. <http://www.boe.moph.go.th/boedb/surdata/disease.php?ds=15>.

14. Sathawornwiwat A, Thaweewigyakarn P, Lekjcharoen P, Jindapom W, Changsan N, Thammawijaya P, et al. An outbreak investigation of influenza A H3N2 in battalion, Surat Thani province, Thailand, August 2014. Weekly Epidemiological Surveillance Report. 2016;47(6):81-8. Thai.

15. Duangsin A, Sirirungruang A, Mitrpanon S. An outbreak influenza A/H1N1 (2009) in a legion recruit training military camp, Roi Et Province, Thailand, April-May 2014. Weekly Epidemiological Surveillance Report. 2015;46(32):497-503. Thai.

16. Silarak K, Namwong T, Lerdsappoontawee S, Sangpakdi M, Buakeaw S, Kampat S, et al. An outbreak investigation of influenza A/H1N1 2009 in a training unit camp, Yasothon Province, Thailand, May 2017. Weekly Epidemiological Surveillance Report. 2018;48(52):817-24. Thai.

17. Oxford J, Berezin EN, Courvalin P, Dwyer DE, Exner M, Jana LA, et al. The survival of influenza A(H1N1)pdm09 virus on 4 household surfaces. Am J Infect Control. 2014 Apr;42(4):423-5.

18. Cosby MT, Pimentel G, Nevin RL, Fouad Ahmed S, Klena JD, Amir E, et al. Outbreak of H3N2 influenza at a US military base in Djibouti during the H1N1 pandemic of 2009. PLoS One. 2013;8(12):e82089.

19. Biggerstaff M, Cauchemez S, Reed C, Gambhir M, Finelli L. Estimates of the reproduction number for seasonal, pandemic, and zoonotic influenza: a systematic review of the literature. BMC Infect Dis. 2014 Sep 04;14:480.

20. Thailand. Health Promotion and Preventive Medicine Division. Royal Thai Army Medical Department. Influenza situation in Royal Thai army surveillance 2014-2017. Thai [cited 2018 Jul 15]. <https://tinyurl.com/yb7bf6ds>.

21. Gray GC, Callahan JD, Hawksworth AW, Fisher CA, Gaydos JC. Respiratory diseases among U.S. military personnel: countering emerging threats. Emerg Infect Dis. 1999 May-Jun;5(3):379-85.

22. National Vaccine Institute. The guidelines of the National Vaccine Institute Steering Committee and Steering Sub-Committee. 2010. Thai [cited 2018 Jul 20]. <http://nvi.ddc.moph.go.th/attach/e-book/update%20file/executive/executive.pdf>.

23. Grabenstein JD, Pittman PR, Greenwood JT, Engler RJ. Immunization to protect the US Armed Forces: heritage, current practice, and prospects. Epidemiol Rev. 2006;28:3-26. Epub 2006 Jun 8.

24. Eick-Cost AA, Tastad KJ, Guerrero AC, Johns MC, Lee SE, Macintosh VH, et al. Effectiveness of seasonal influenza vaccines against influenza-associated illnesses among US military personnel in 2010-11: a case-control approach. PLoS One. 2012;7(7):e41435. Epub 2012 Jul 31.

25. MacIntosh VH, Tastad KJ, Eick-Cost AA. Mid-season influenza vaccine effectiveness 2011-2012: a Department of Defense Global, Laboratory-based, Influenza Surveillance System case-control study estimate. Vaccine. 2013 Mar 25;31(13):1651-5. Epub 2013 Feb 6.

26. Farrell M, Sebeny P, Klena JD, Demattos C, Pimentel G, Turner M, et al. Influenza risk management: lessons learned from an A(H1N1) pdm09 outbreak investigation in an operational military setting. PLoS One. 2013 Jul 10;8(7):e68639. Print 2013.

27. Centers for Disease Control and Prevention. Interim guidance on infection control measures for 2009 H1N1 influenza in healthcare settings, including protection of healthcare personnel. 2010 Jul 15 [cited 2018 Oct 10]. <https://www.cdc.gov/h1n1flu/guidelines_infection_control.htm>.

28. Karnjanapiboonwong A, Iamsirithaworn S, Sudjai U, Kunlayanathee K, Kunlayanathee P, Chaipanna N, et al. Control of a pandemic influenza A (H1N1) 2009 outbreak in a prison, Saraburi Province, Thailand, August 2009. OSIR. 2011 Dec;4(2):12-6.

29. Thailand. Health Promotion and Preventive Medicine Division. Royal Thai Army Medical

Department. Guidelines for heat stroke prevention. Thai [cited 2018 Jul 15]. <https://tinyurl.com/y6updoyo>.

30. World Health Organization. Infection-control measures for health care of patients with acute respiratory diseases in community settings. Geneva: World Health Organization; 2009 [cited 2018 Jul 15]. <http://apps.who.int/iris/bitstream/10665/70093/1/WHO_HSE_GAR_BDP_2009.1_eng.pdf>.