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Situation of melioidosis in Thailand, 2006-2015

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Abstract

Melioidosis is an important, yet neglected tropical disease with a high fatality rate, especially among septicemia cases. This descriptive study on national passive surveillance data characterized melioidosis in animals and humans throughout Thailand from 2006–2015, and identified associations between its occurrence and environmental factors: rainfall and temperature. We found 145 animal cases, including 196 animals of 23 species, and 23,174 human cases with 200 deaths. The estimated incidence rate per 100,000 was 3.61 in sheep, 1.90 in goat, 0.03 in pigs, 0.02 incattle and 3.63 in humans. The male-to-female ratio for human melioidosis was 1.66:1, and the age group most affected was from 55 years old upward. Animal and human melioidosis occurred in all six regions. Of 77 provinces, melioidosis was distributed in 32 provinces (41.56%) in animals and 74 provinces (96.10%) in humans. Twelve significant spatio-temporal clusters ($p \leq 0.05$) of human melioidosis were detected, including the provinces in the north-eastern (n=14), northern (n=3), central (n=2), eastern (n=1), and southern (n=1) regions. We observed an upward annual trend (Kendall's tau statistic (s) =0.556, p=0.03) of human melioidosis and seasonality of both animal (s=135, p<0.001) and human (s=312, p=0.01) melioidosis. We detected significant increases of 0.22% and 0.21% in animal cases, and 0.14% and 0.15% in human cases with a 1 m.m. increase in rainfall in the preceding 1-month and 2-month intervals, and a 19.10% increase in animal cases with a 1 °C increase in temperature in the preceding 2-month intervals. The findings highlight the distribution of animal and human melioidosis nationwide, its increasing trend, and associations with environmental factors; these warrant awareness and preparedness in national veterinary and health care services.

Key words: cluster, melioidosis, seasonality, trend, Thailand

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Introduction

Melioidosis is an important, yet neglected tropical disease (Dance, 1991; Hotez et al., 2015). It is caused by *Burkholderia pseudomallei* (*B. pseudomallei*), a gram-negative saprophytic bacterium naturally found in soil and water in endemic areas e.g. Southeast Asia and tropical Australia (Sprague and Neubauer, 2004). There is also increasing evidence of its spread to new areas (Cheng and Currie, 2005; Currie, 2008). Melioidosis is transmitted through three major routes; ingestion, inhalation, and percutaneous inoculation, and affects animals and humans, including mammals, reptiles, birds, and fish (Dance, 1991; Sprague and Neubauer, 2004). Its clinical presentations are not specific and a laboratory diagnosis is the key to confirmation (Dance, 1991). Clinical infection in animals and humans varies from mild through chronic to acute septicemia and fatal (Choy et al., 2000). The significantly high fatality rates among human septicemia cases have been recognized as being strongly associated with underlying risk factors, such as diabetes and other chronic diseases (Limmathurotsakul and Peacock, 2011).

Melioidosis has been considered a disease constituting a public health threat in Thailand for more than two decades (Leelarasamee, 2000). Human melioidosis has been listed as a notifiable disease since 2002, but only a few cases were reported early on. The characteristics of cases and risk factors have mainly been described in prospective hospital-based studies in the north-eastern, northern, and eastern regions (Suputtamongkol et al., 1999; Chaiwarith et al., 2005; Waiwarawooth et al., 2008). A recent study in the north-eastern region showed an increasing incidence of human melioidosis (Limmathurotsakul et al., 2010). Despite its prevalence, another study has revealed that only one fourth of Thais know about the disease (Chansrichavala et al., 2015). The reporting of melioidosis in animals is not compulsory, but there have been records of cases in central and regional veterinary laboratory databases. During 2006–2010, there were culture-confirmed cases in domestic and captive wild animals, with the highest incidence rate in goats (Limmathurotsakul et al., 2012). Agriculture, including livestock farming, has been promoted throughout the country to enable expansion into large-scale production, which may increase the risk of acquiring melioidosis. As a result of these findings, the incidence and prevalence of melioidosis throughout Thailand should be explored broadly using data on both animal and human melioidosis cases to generate the additional and complementary information necessary to plan effective preventive measures in animals and humans, and provide a one health strategy and approach.

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B. pseudomallei inhabits soil and water, and its presence and geographical distribution can be reflected by the incidence of animal and human cases of melioidosis (Limmathurotsakul and Peacock, 2011). In addition, its survival and transmission are undoubtedly influenced by several environmental factors (Cheng and Currie, 2005). This descriptive study, employing data on animal cases and national passive surveillance data on human melioidosis from every region over the same period, coupled with environmental data, focused on characterizing melioidosis cases in animals and humans in Thailand over a period of 10 years (2006–2015), and identifying the association between the disease and two environmental factors: mean monthly rainfall and temperature.

Materials and methods

Study area

Thailand is located in the heart of Southeast Asia. The kingdom covers an area of 513,115 km^2 and had a human population of 65,027,401 in 2015. It has some distinct geographical characteristics that classify the country into six regions: northern, north-eastern, central, eastern, western, and southern. The northern and western regions are typified by mountainous areas, the north-eastern region by plateaus, the central region by plains, the eastern region by short mountain ranges and coastal areas, and the southern region by a peninsular. Three seasonal monsoon patterns are recognized: the south-western monsoon from mid-May to mid-October, with abundant rain across most of the country; the north-eastern monsoon from mid-October to mid-February, with rain in the south, but a dry and mild temperature for the rest of the country; pre-monsoon from mid-February to mid-May, characterized by dry weather and a warmer temperature. As reported by the Thailand Meteorological Department, in 2015 the average annual rainfall was 1,419.6 mm. and the annual mean temperature was 27.9 °C.

Study design and data sources

A descriptive retrospective study was undertaken using national passive surveillance data for melioidosis in animals and humans over a 10-year period (2006–2015). Data were collected from three main sources: the National Institute of Animal Health (NIAH), the Department of Livestock Development (DLD), the Bureau of Epidemiology (BoE), the Department of Disease Control, and the Thai Meteorological Department (TMD).

Regional veterinary laboratories and National Institute of Animal Health (NIAH) under the DLD are responsible for animal disease diagnoses in the country. NIAH located in the central region serves

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as the center, and the other seven are located in different regions. There are two centers in the north-east, and one each in the north, central, east, west, and south (Fig.3A). Reporting melioidosis in animals is not compulsory; however, data on cases are routinely stored in the database, submitted, and updated to the center on a weekly basis. The data on each case contain the date of the case submission, the species of animal, the address of the farm(s), and the number and types of specimens. Livestock population data were obtained from the Information and Technology Center, DLD. To describe the characteristics of cases, we also collected data on cultured-confirmed melioidosis in animals from the regional veterinary laboratory in the southern region, namely, the Veterinary Research and Development Center (Upper southern region), related to age, sex, clinical signs, and survival period.

Melioidosis in humans is a notifiable disease in Thailand. Cases in health care centers and hospitals nationwide are reported to the BoE and disseminated in the Annual Epidemiological Surveillance Report (AESR) (http://203.157.15.110/boeeng/annual.php). The data include two components. The case data comprises the monthly number of human cases, as well as the number of cases by age group, sex, occupation, type of hospital attended, and type of patient. The population data comprises the mid-year population, distinguished by age group and sex.

The data on average monthly rainfall and the temperature in Thailand was requested from the TMD.

Case definitions

Cases of animal melioidosis are defined as any animal culture-positive for *B. pseudomallei* at the DLD veterinary diagnosis laboratories. The BoE defines a probable human melioidosis case as any person with a high fever, and with either an abscess in any part of the body/organ with no other causative agents found, or obvious signs of hand or leg paralysis plus gram-negative positive staining. A confirmed case is any person who fulfills the definition of a probable case and is culture-positive, or has a four-fold increase in antibodies on an indirect hemagglutination test or an indirect fluorescent antibody test (Kuharat, 2003). The human cases in this study included both probable and confirmed cases.

Data analysis

The data analyses were performed using descriptive statistics. Cases were characterized by the estimated incidence rate per 100,000 population or percentages by gender, age group, and occupation, as appropriate. The fatality rate was the percentage of dead among the reported cases. The data were checked for normality prior to performing statistical tests. The median and deviation values of monthly cases and annual cases (median; minimum, maximum, interquartile range ($IQR=IQR_3-IQR_1$) were calculated and summarized. Any clusters of melioidosis in space and time were detected (SatScan v9.4.4). Temporal clusters were compared for 50% of time length, segregated over one year, and spatial clusters were compared for 50% of the population within a 100 km radius. A space–time permutation model not requiring population data was applied to analyze the animal data. Poisson modeling was applied to analyze the human data. Clusters of melioidosis were detected using the non-parametric Mann–Kendall test, with and without correlation (R v3.3.3). The association between mean monthly rainfall and temperature and melioidosis cases in animals and humans were measured for several periods of time using negative binomial regression and Poisson regression models respectively (STATA v12). The association was measured at a significance of p-value≤0.05. Choropleth maps were developed to show the distribution of cases by province and the disease clusters (QGIS v2.1.8).

Results

Characteristics of cases in animals and humans

Over the period 2006–2015, there were 145 culture-confirmed animal melioidosis cases, including 196 animals (some cases included more than one animal) of 23 species (Table 1). The number of melioidosis cases ranged between 3 and 25 cases per year (median=15; IQR=22.25–7.5). The culture-positive animal melioidosis comprised mammals and reptiles (Table 1). The cases were submitted to the veterinary laboratory by officers (n=123) and farmers (n=22). The types of specimen from the 145 cases comprised four groups: sick animals (n=5), dead animals (n=59), organs (n=76), and others, including swabs of nasal discharge, blood, and milk (n=5).

Based on data from the Veterinary Research and Development Center (Upper southern region), only data for the goats were complete and were chosen for analysis. There were 41 cases of goat melioidosis in total; of 39 cases that sex of goats were recorded, 30 (76.9%) were female and 9 (23.1%) were male. Their ages ranged between 2 and 72 months, with a median age of 8 months. The clinical presentations, as observed and recounted by the owners of 31 goats, were categorized into 10 groups. The group of clinical presentations most commonly observed were fever, lethargy, weakness, and anorexia (64.5%), followed by cough, nasal discharge, hyperpnoea, and dyspnea

(45.2%), and stiff gait, paresis, and paralysis (25.8%) (Figure 1). Among the fatal cases, the survival period from the first observed clinical presentations to fatality ranged from 1 to 38 days, with a median of 8 days.

There were 23,174 reported cases in humans over the same period, with the number of annual reported cases ranging between 651 and 3,711 cases (median=2690; IQR=3157–1161). There were 62.35% men and 37.65% women, comprising a male to female ratio of 1.66:1. The high percentages of observed cases were in three age groups: 45–54 (23.16%), 55–64 (22.54%), and ≥65 (19.59%). About 60.82% of cases worked in agriculture and the other 39.18% worked in non-agricultural occupations. The cases comprised 68.91% out-patients and 31.09% in-patients (Table 2). The percentages of patients grouped by type of health care units were as follows: regional hospital (13.47%), general hospital (24.44%), community hospital (60.51%), and others (1.58%).

Incidence rates and fatality rates

The estimated incidence rates per 100,000 animals per year over the study period were 3.61 in sheep, 1.90 in goats, 0.03 in pigs, and 0.02 in cattle (Table 1).

The annual human incidence rate per 100,000 of the population ranged from 1.04 to 6.11, with an estimated incidence rate over the study period of 3.63. The annual fatality rates were 0.14–3.45%, with a mean rate over the study period of 0.86%. The estimated incidence rates by region over the study period were 9.05 in the north-eastern, 1.87 in northern, 1.60 in eastern, 0.57 in central, 0.53 in southern, and 0.36 in western regions. The incidence rates by age group were higher in the older age groups: 45–54 (5.82), 55–64 (8.93), and 65 and older (8.50) (Table 2).

Annual trend and monthly seasonality

The average monthly animal cases over the study period ranged between 0 and 1.5 cases, with a median of 0.75 cases; the months with a higher number of cases than the median were January and August–December. The upward annual trend in animal melioidosis (Kendall's tau statistic (s=0.477, p=0.71) was detected, but it was not significant.

The average monthly human cases ranged between 154.50 and 271.50, with a median of 193.75 cases; the months with more human cases than the median were January and July–December (Figure 2). A significant upward annual trend in human melioidosis (s =0.556, p=0.03) was detected. There was a significant monthly trend in human (s=312, p=0.01) and animal melioidosis (s=135, p<0.001). The three months with a significant upward seasonal trend in animal melioidosis were January (s=27, p=0.01), September (s=32, p=0.003), and November (s=24, p=0.03).

Spatial distribution

Animal melioidosis cases were reported in 32 of 77 provinces (41.56%), distributed in every region (Figure 3A). The five provinces with the highest number of positive cases were Ratchaburi (40 cases) in the western region, Songkhla (22 cases) in the southern region, Khon Kean (17 cases) in the north-eastern region, Nakhon Sawan (16 cases) in the central region, and Trang (5 cases) in the southern region whereas each of the other 27 provinces had 1–3 cases over the study period.

Human cases were reported in 74 of 77 provinces (96.10%). The provinces without reported cases were Ang Thong and Samut Songkram in the central region and Yala in the southern region. The first two provinces also had no records of cases in animals (Figure 3B). The provinces that presented the highest incidence rates, 90% above the rest, were all in the north-eastern region, namely Mukdahan (35.46), Amnat Charoen (29.29), Si Sa Ket (19.28), and Roi Et (17.49). Three fourths of all provinces had an estimated annual incidence rate below 3.90 (Figure 4).

Melioidosis clustering

Scan statistics showed no significant spatio-temporal clustering of melioidosis in animals. Purely spatial analysis detected 18 clusters of human melioidosis. The clusters included 18 provinces in the north-east, and a province in the north (Figure 5A). The spatio-temporal analysis detected 12 clusters of human melioidosis with a number of observed cases about 1.63–6.17 times greater than the expected cases. Five clusters were in the north-eastern region, comprising three clusters of 11 provinces in 2011–2015, a cluster including two provinces in 2010–2013, and two provincial clusters in 2011–2015 and 2010–2012. The rest were clusters that included one province and were located outside the north-eastern region: three clusters in the north in 2011–2014, 2010–2013, and 2011, two clusters in the central region in 2012 and 2015, a cluster in the east in 2009–2012, and a cluster in the south in 2015 (Figure 5B).

Environmental associations

The average monthly rainfall in mm. during the study period ranged from 3.6 to 319.7 (median=132.7; IQR=214.3–47.7). There were significant associations between the average monthly rainfall and the occurrence of melioidosis in animals and humans. The incidence rate for animal melioidosis increased by 0.22% and 0.21% with an increase in the average monthly rainfall of 1 mm.

in the preceding 1- and 2-month periods respectively, and that for human melioidosis increased by 0.14% and 0.15% with an increase in the average monthly rainfall of 1 mm. in the preceding 1 and 2-month periods respectively. The average monthly temperature ranged from 22.8 °C to 30.8 °C (median=27.7 °C; IQR=28.4–26.4). Only animal melioidosis was significantly associated with average monthly temperature. The incidence rate increased by 19.10% with an increase in the average monthly temperature in the preceding 2-month period of 1 °C (Table 3).

Discussion

Over a 10-year period, 2006–2015, culture-confirmed animal cases were found to have occurred in around half of all provinces (32/77). Human cases, included those fulfilled the case definition criteria of probable and confirmed cases (Kuharat, 2003), occurred in almost every province over the same period (74/77). Altogether, melioidosis was observed in most provinces in Thailand.

We observed animal melioidosis cases in mammals and reptiles, several of them were species exotic to Thailand. The first two highest numbers of cases were found in Ratchaburi and Songkhla provinces as mentioned above. The estimated incidence rates were highest in sheep, followed by goats, pigs, and cattle, quite similar to that observed in 2006–2010 (Limmathurotsakul et al., 2012), and were consistent with observations in Australia (Choy et al., 2000). Clinical presentations in goats, as observed by the farmers, were unspecific, as had also been described in the literature (Sprague and Neubauer, 2004). Concurrent infections with parasites and bacterial pneumonia (data not shown) could have also complicated the clinical presentations.

The gender and age of those diagnosed with human melioidosis in this study were consistent with most previous reports. There were more male than female cases, and adults from about 45–50 years old onward were most affected (Bhengsri et al., 2011; Churuangsuk et al., 2016; Limmathurotsakul et al., 2010). The higher risk of exposure in men and increasing prevalence of underlying risk factors for melioidosis with age could explain these findings. The majority of cases concerned agricultural workers, consistent with the results reported in north-eastern Thailand (Limmathurotsakul et al., 2010), this could be rooted in the fact that the north-eastern region was primarily agricultural. This finding was similar to that found in Malaysia (Zueter et al., 2016) but differed from the situation in eastern Thailand, where most cases concern laborers (Waiwarawooth et al., 2008), and southern Thailand, where only one third of cases relate to high-risk occupations (rice farmers, fruit agriculturists) (Churuangsuk et al., 2016).

In this study, the estimated incidence rate per 100,000 populations of human melioidosis was 3.63 for the country, 9.05 for the north-eastern region, and 0.36-1.87 for the other regions (Table 2). The observed fatality rates of 0.86% (0.14%-3.45%) were far lower than that of 9% in southern region during 2002-2011 (Churuangsuk et al., 2016), 47% in eastern region during 2001-2006 (Waiwarawooth et al., 2008), 19% in Singapore during 2003-2012 (Liu et al., 2015) and 33% in Malaysia during 2001-2015 (Zueter et al., 2016). It could be due to low rate of reporting dead cases in the national passive surveillance system (Anont et al., 2014).

The clusters of human melioidosis cases were mostly found in the north-eastern region (Figure 5A-B). The cases should have reflected the abundance of *B. pseudomallei* in the environment comparing with other regions from the study of Vuddhakul et al. (1999), hence, pointed the north-eastern region as good habitat for *B. pseudomallei* and high risk area of melioidosis in humans. In addition, a significant and consistent increasing trend in human melioidosis was detected in this study and is supported by the observations in the north-eastern region from active surveillance data over the period of 1997–2006 (Limmaturotsakul et al., 2010). This trend differs from Singapore, where the incidence of disease has declined (Lo et al., 2009).

A significant monthly seasonality of melioidosis occurrence is detected in both animals and humans. The numbers of animal and human cases were higher in certain months than others (Figure 2), with significantly higher numbers of cases in animals in January, September, and December, these months being influenced by the monsoon, with an abundance of rainwater which plays an important role as vehicle for *B. pseudomallei* transmission from soils to animals and humans (Liu et al., 2015). Moreover, Singapore which is influenced by a similar monsoon season has also observed high numbers of human cases in the months of January and July–October (Liu et al., 2015). However, this monthly seasonality can be affected by unprecedented off-season events, such as heavy rainfall, strong winds, and flash flooding (Lo et al., 2009).

Our study shown in Table 3 was based on monthly aggregated data for cases, and we found an increasing number of animal and human cases when the amount of rainfall in the preceding 1 month and 2-month periods increased. In addition, an increase in the number of animal cases was detected when the temperature in the preceding 2-month period increased. It is possible that an environment contaminated with *B. pseudomallei* were induced and then maintained by an increase amount of rainfall and high temperature, thus extended the risk exposure period to animals and humans for several weeks after those adverse events.

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Conclusions

Our findings from the national passive surveillance data highlight the distribution of melioidosis using the results concerning the occurrence of the disease in animals and humans. The highest numbers of animal cases were from the north-eastern region followed by the southern region. While in humans the highest incidence rates and most of the disease clusters were found among the provinces in north-eastern region. The continued increase in the incidence of human melioidosis, seasonality and the time lag between adverse environmental events (increased rainfall and temperature) and the occurrence of cases was observed. These suggest the collaboration of veterinarians and public health officers to work together under one health strategy in order to reduce prevalence and fatality rates of the disease and should be addressed in providing advice to the public and guidelines for good husbandry for farmers.

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Table 1 Estimated incidence rates[a] of culture-positive animal melioidosis in Thailand, 2006–2015.

Animals	Total population[b]	No. culture-positive over 10 years		Incidence rate
		Cases	Animals	
Sheep	47,060	16	17	3.61
Goats	427,192	65	81	1.90
Pigs	9,064,296	8	28	0.03
Cattle	7,224,075	15	18	0.02
Other livestock/pets[c]	NA	19	27	NA
Captive zoo animals[d]	NA	22	25	NA
Total	NA	145	196	NA

[a] Number of culture-positive animals/100,000 animals/year; NA = not available.

[b] Average number of animals per year in 2006–2015.

[c] Farmed deer (14 cases,20 animals); farmed crocodiles (1,3); buffaloes (2,2); horse (1,1); dogs (1,1).

[d] Zebra (3,6); camels (3,3); monkeys (2,2); gibbons (2,2); orangutan (1,1); ruffed lemur (1,1); deer (1); chamois (1,1); red lechwe (1,1); kangaroos (2,2); albino wallaby (1,1); flat-headed cat (1,1); wild boar (1,1); sea lion (1,1); Burmese python (1,1).

Table 2 Characteristics of human melioidosis in Thailand, 2006–2015[a].

Category	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Overall
No. cases	651	920	1098	1350	2902	3920	3711	2836	2544	3242	23174
Deaths	7(1.08)	8(0.87)	8(0.73)	11(0.81)	15(0.52)	10(0.26)	13(0.35)	4(0.14)	12(0.47)	112(3.45)	200(0.86)
Gender	651	920	1094	1350	2902	3920	3711	2836	2544	3242	23174
Male	402	552	687	831	1726	2359	2309	1825	1681	2077	14449(62.35)
Female	249	368	411	519	1176	1561	1402	1011	863	1165	8725(37.65)
Occupation	529	691	899	1038	2376	3630	3618	2829	2542	3242	21398
Agriculture	363	465	599	705	1433	2368	2123	1687	1501	1771	13015(60.82)
Non-agriculture	166	226	304	333	943	1262	1495	1142	1041	1471	8383(39.18)
Type of patient[b]	651	-	1098	1350	2902	3920	3711	2836	2544	3242	22254
Out-patient	346	-	573	772	1920	2644	2728	2203	1908	2241	15335(68.91)
In-patient	305	-	525	578	982	1276	983	633	636	1001	6919(31.09)

Category	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Overall
Age group	650	920	1093	1349	2894	3920	3704	2836	2544	3242	23152
<15	66	105	103	127	340	388	368	252	237	311	2297(9.92)
15–24	39	39	35	50	120	163	128	102	71	114	861(3.72)
25–34	26	63	87	110	178	254	213	141	121	175	1368(5.91)
35–44	121	153	179	222	472	617	545	425	338	437	3509(15.16)
45–54	142	203	257	303	659	892	815	681	649	762	5363(23.16)
55–64	150	195	235	294	586	806	869	704	646	733	5218(22.54)
≥65	106	162	197	243	539	800	766	531	482	710	4536(19.59)
Incidence by age group[c]	650	920	1093	1349	2894	3920	3704	2836	2544	3242	23152
<15	0.49	0.79	0.79	0.99	2.68	3.10	2.99	2.07	1.98	2.61	1.82
15–24	0.40	0.40	0.36	0.52	1.25	1.69	1.33	1.05	0.74	1.19	0.89
25–34	0.24	0.58	0.81	1.03	1.69	2.44	2.10	1.41	1.23	1.80	0.17
35–44	1.11	1.39	1.63	2.02	4.32	5.64	5.03	3.93	3.16	4.09	3.23
45–54	1.74	2.41	2.96	3.38	7.15	9.45	8.51	7.07	6.50	7.52	5.82
55–64	3.15	3.96	4.58	5.47	10.37	13.44	13.72	10.85	9.58	10.41	8.93
≥65	2.24	3.38	4.07	4.91	10.60	15.24	14.11	9.12	7.94	11.17	8.50

Category	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Overall
Incidence by region[d]	651	920	1098	1350	2902	3920	3711	2836	2544	3242	23174
Northeast	2.34	3.57	4.06	4.97	11.75	15.33	14.69	11.21	9.96	12.27	9.05
North	1.29	0.71	1.53	1.86	1.96	3.47	2.67	2.23	1.74	1.31	1.87
East	0.51	1.32	0.95	1.31	2.01	1.89	2.75	1.89	1.56	1.66	1.60
Center	0.22	0.22	0.30	0.39	0.62	1.00	0.66	0.55	0.64	1.08	0.57
South	0.06	0.13	0.31	0.35	0.37	0.79	0.78	0.62	0.61	1.22	0.53
West	0.16	0.13	0.28	0.09	0.25	0.47	1.41	0.37	0.28	0.12	0.36
Total incidence[e]	**1.04**	**1.46**	**1.74**	**2.13**	**4.56**	**6.11**	**5.77**	**4.39**	**3.92**	**4.98**	**3.63**

[a]Values are no. (%) except as indicated

[b]No data in 2007

Mid-year population from 2006–2015: 62,623,416; 62,933,515; 63,214,022; 63,457,403; 63,701,703; 64,181,001; 64,266,405; 64,621,302; 64,955,313; 65,027,401, and the overall 638,938,481

Incidence = incidence rate/100,000 population;

[c] The annual (overall) no. of cases by age group/annual (overall) no. of population by age group *100,000

[d] The annual (overall) no. of cases by region/annual (overall) no. of population by region *100,000

[e] The annual (overall) no. of cases/annual (overall) no. of mid-year population *100,000.

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Table 3 Temporal association between melioidosis cases, average monthly rainfall, and temperature, Thailand, 2006–2015.

Category	No lag			1-month lag			2-month lag		
	IRR	95%CI	P value	IRR	95%CI	P value	IRR	95%CI	P value
Animal cases									
Rainfall	1.0022	1.0000-1.0045	0.06	1.0028	1.0007-1.0050	0.01*	1.0029	1.0002-1.0055	0.03*
Temperature	0.9668	0.8444-1.0940	0.59	1.0673	0.9433-1.2076	0.30	1.1910	1.0338-1.3721	0.02*
Human cases									
Rainfall	1.0007	0.9995-1.0018	0.25	1.0014	1.0002-1.0025	0.02*	1.0015	1.0004-1.0026	0.005*
Temperature	0.9635	0.9108-1.0193	0.20	0.9823	0.9302-1.0374	0.52	1.0334	0.9796-1.0908	0.23

IRR=Incidence rate ratio; *significant ($p \leq 0.05$)

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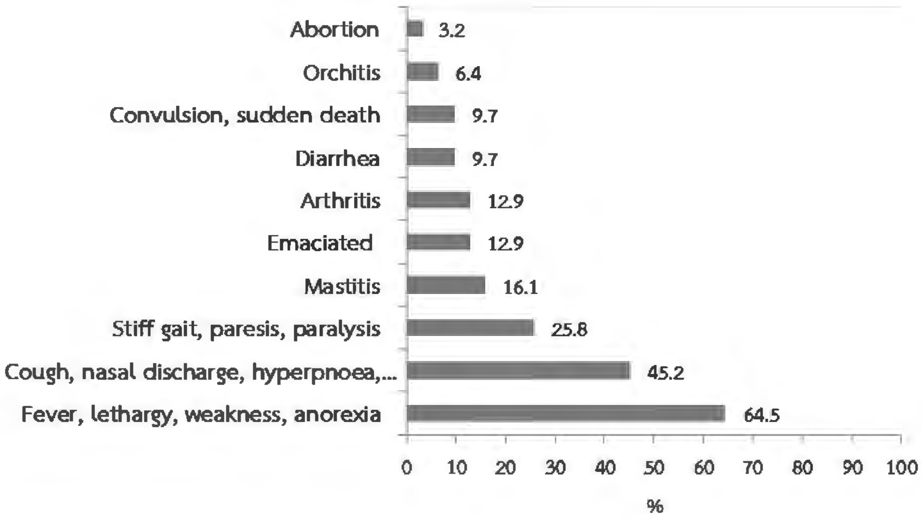

Figure 1 Clinical presentations[a] of melioidosis in 31 culture-positive melioidosis goats in Thailand, 2006–2015[b].

[a] Clinical signs were reported by the owners and were grouped into 10 categories; a report of one or more signs in the same group was counted once.

[b] Source: Veterinary Research and Development Center (Upper southern region)

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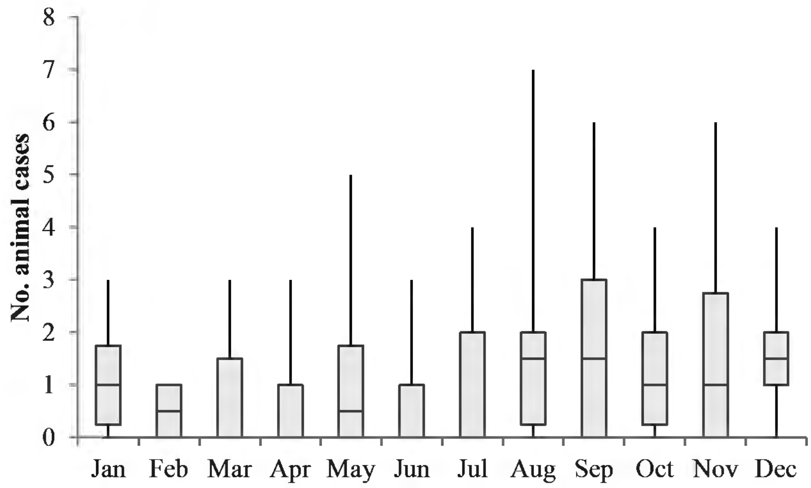

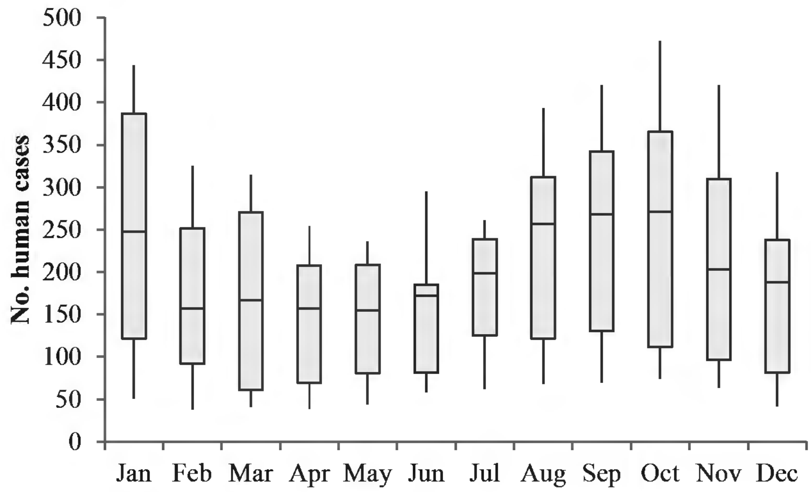

Figure 2 Distribution of melioidosis cases by month, Thailand, 2006–2015; Box plots summarizing monthly maximum number of cases, 75% of cases, median, 25% of cases, and minimum number of cases in animals and humans.

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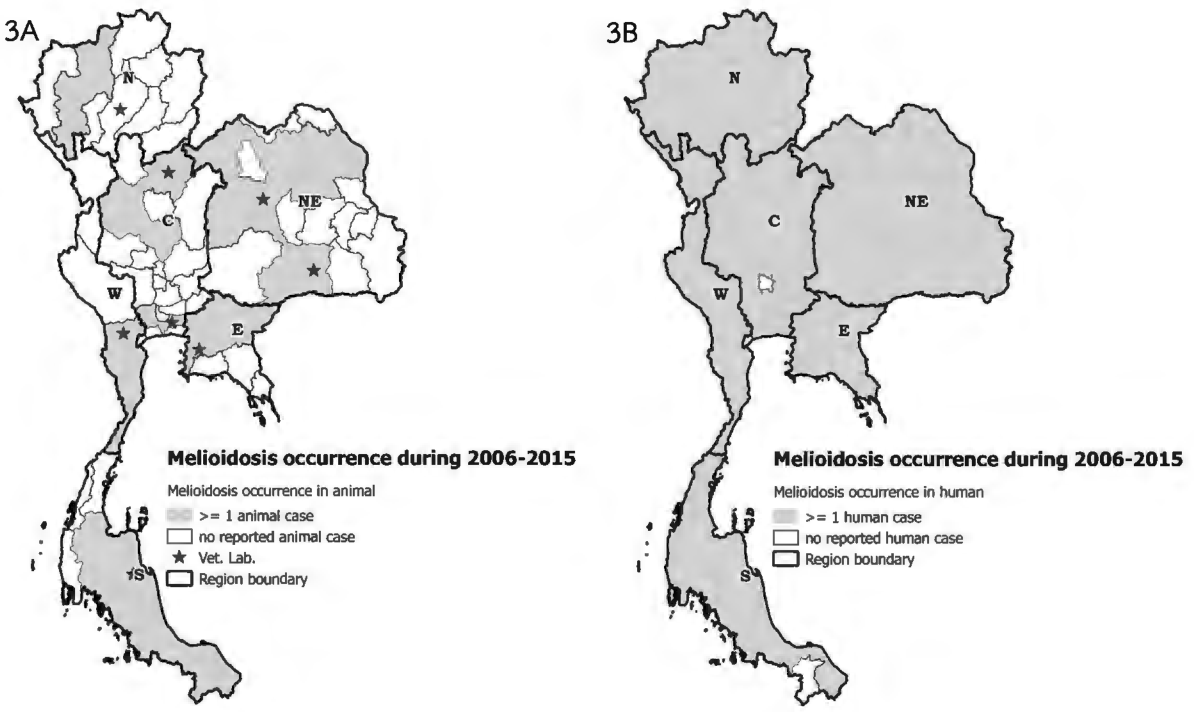

Figure 3 Spatial distributions of melioidosis occurrence by province in Thailand, 2006–2015; animal melioidosis occurrence and locations of veterinary laboratories (3A), human melioidosis occurrence (3B).

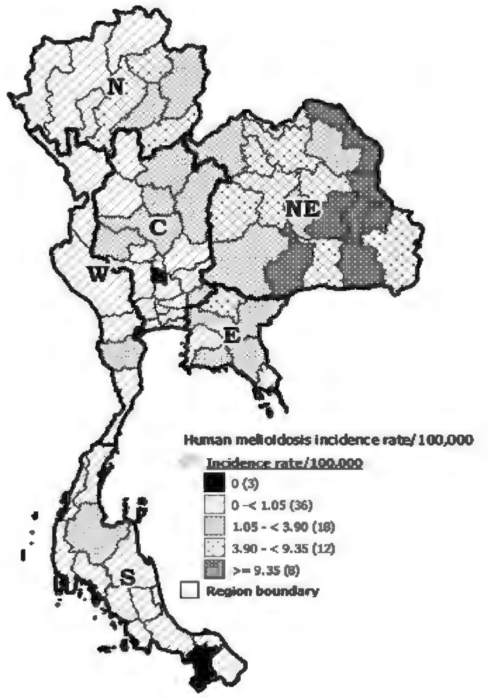

Figure 4 Incidence of human melioidosis per 100,000 population in Thailand by province, 2000-2015.

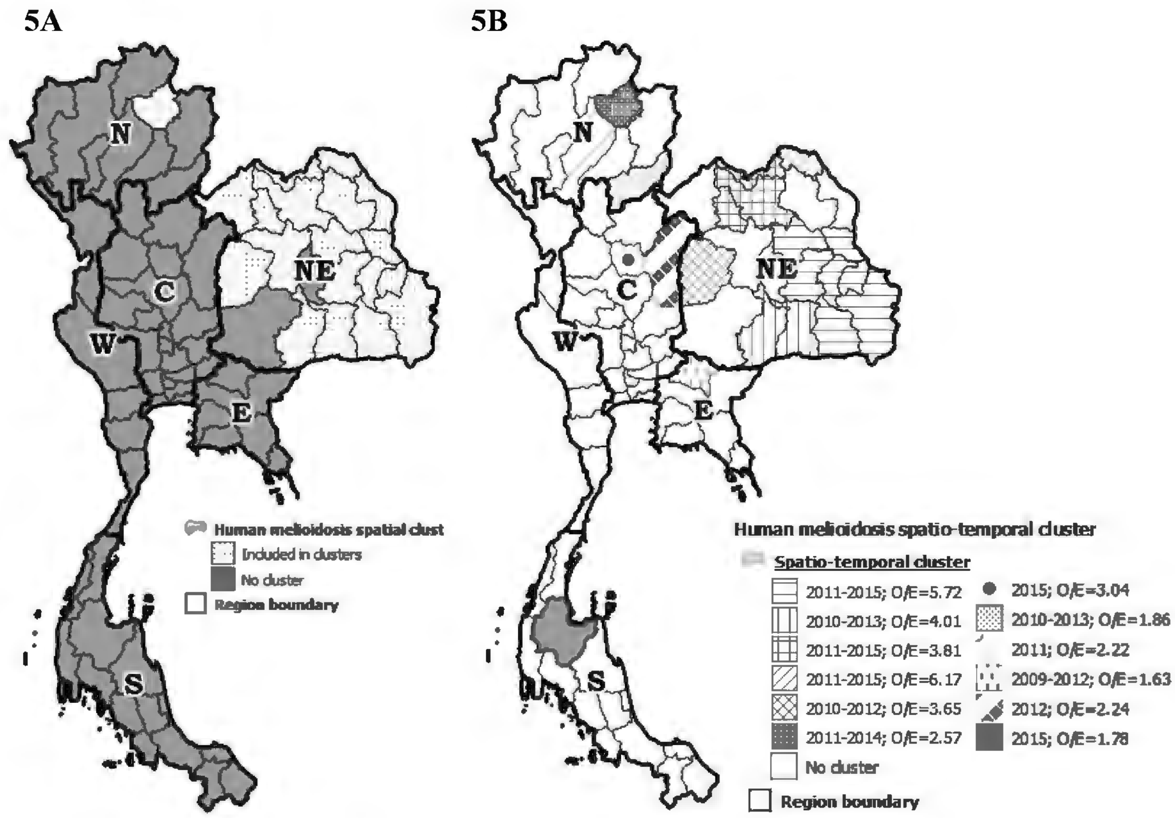

Figure 5 Clusters of human melioidosis in Thailand, 2006–2015; (A) Significant spatial clusters of human melioidosis detected in 18 provinces of the north-eastern region and a province in the northern region. (B) Twelve significant spatio-temporal clusters of human melioidosis detected in all except the western region.

สถานการณ์โรคเมลิออยด์ในประเทศไทย พ.ศ.2549-2558

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บทคัดย่อ

โรคเมลิออยด์เป็นโรคสำคัญที่ยังถูกละเลยถึงแม้มีอัตราป่วยตายสูงโดยเฉพาะในกลุ่มผู้มีภาวะติดเชื้อในกระแสเลือด การศึกษาครั้งนี้ใช้ข้อมูลการเฝ้าระวังเชิงรับของโรคเมลิออยด์ในสัตว์และในคนในประเทศไทยระหว่าง พ.ศ. 2549-2558 เพื่ออธิบายลักษณะการเกิดโรคและความสัมพันธ์ระหว่างการเกิดโรคกับปัจจัยด้านสภาพแวดล้อม 2 ประการ ได้แก่ ค่าเฉลี่ยปริมาณน้ำฝนและอุณหภูมิ ซึ่งพบว่ามีตัวอย่างจากสัตว์ 145 ตัวอย่าง ประกอบด้วยตัวสัตว์ 196 ตัว และ 23 ชนิดสัตว์ ผู้ป่วยโรคเมลิออยด์ 23,174 ราย ผู้ป่วยเสียเสียชีวิต 200 ราย ประมาณการอัตราอุบัติการณ์ของโรคต่อหน่วยประชากร 100,000 เท่ากับ 3.61 ในแกะ 1.90 ในแพะ 0.03 ในสุกร 0.02 ในโค และ 3.63 ในคน สัดส่วนการเกิดโรคในคนเพศชายต่อเพศหญิงเท่ากับ 1.66 ต่อ 1 และ อัตราอุบัติการณ์สูงในกลุ่มอายุตั้งแต่ 55 ปีขึ้นไป พบโรคเมลิออยด์ในสัตว์และคนกระจายทั่วทุกภาค ในสัตว์พบการเกิดโรคใน 32 จังหวัด (41.56%) ในคนพบการเกิดโรคใน 74 จังหวัด (96.10%) จาก 77 จังหวัดของประเทศ ผลการวิเคราะห์การเกิดโรคเชิงเชิงพื้นที่และเวลาพบการเกิดโรคในคนมากอย่างมีนัยสำคัญทางสถิติ 12 กลุ่ม ครอบคลุมพื้นที่ดังนี้ ภาคตะวันออกเฉียงเหนือ 14 จังหวัด ภาคเหนือ 3 จังหวัด ภาคกลาง 2 จังหวัด ภาคตะวันออกและภาคใต้ ภาคละ 1 จังหวัด อัตราอุบัติการณ์ของโรคในคนเพิ่มขึ้นอย่างมีนัยสำคัญ (Kendall's tau statistic (s) =0.556, p=0.03) และพบจำนวนสัตว์ (s=135, p<0.001) และ คน (s=312, p=0.01) เกิดโรคเป็นจำนวนมากจำเพาะในบางเดือนของปีอย่างมีนัยสำคัญ มีความสัมพันธ์ระหว่างการเกิดโรคในสัตว์และคนกับปริมาณน้ำฝนที่เพิ่มขึ้น โดยพบสัตว์ป่วยเพิ่มขึ้น 0.22% และ 0.21% และพบผู้ป่วยเพิ่มขึ้น 0.14% และ 0.15% ต่อปริมาณน้ำฝนที่เพิ่มขึ้น 1 ม.ม. ในช่วงก่อนหน้า 1 เดือน และ 2 เดือน ตามลำดับ และพบเฉพาะความสัมพันธ์ระหว่างการเกิดโรคในสัตว์กับอุณหภูมิที่เพิ่มขึ้น โดยพบสัตว์ป่วยเพิ่มขึ้น 19.10% ต่ออุณหภูมิที่เพิ่มขึ้น 1 °C ในช่วงเวลาก่อนหน้า 2 เดือน ผลการศึกษาที่สำคัญคือ มีการเกิดโรคเมลิออยด์ในสัตว์และคนกระจายทั่วประเทศไทย มีแนวโน้มการเกิดโรคเพิ่มขึ้น และการเกิดโรคมีความสัมพันธ์กับปัจจัยด้านสภาพแวดล้อม จึงต้องตระหนักและเตรียมความพร้อมเพื่อการควบคุมป้องกันที่มีประสิทธิภาพมากขึ้นทั้งในส่วนของการให้บริการทางสัตวแพทย์และทางสาธารณสุข

คำสำคัญ: ความเป็นกลุ่มก้อน, โรคเมลิออยด์, การกระจายตามฤดูกาล, แนวโน้ม, ประเทศไทย