Human *Streptococcus suis* Outbreak in Phayao Province, Thailand, 2007

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Introduction

Streptococcus suis is a gram-positive bacteria found predominantly in porcine species. The epizootiology of *S. suis* occurrence among pigs is complex; it usually occurs as normal flora, but may be infectious or even lethal, especially among weaning piglets[1,2]. Human disease from *S. suis* infection can manifest as meningitis, septicemia, endocarditis, toxic shock syndrome, arthritis, acute deafness, or other[3]. Human infections generally occur sporadically; outbreaks are uncommon[2]. When they do occur, outbreaks are typically small to medium in scope[4]. To date, more than 400 human cases have been reported worldwide, mostly in areas of intensive pig production or consumption[3]. It is likely that this underestimates the burden of disease.

The first outbreak of *S. suis* infection in Thailand was reported in 1993[5]. That outbreak occurred in Lamphun; ten cases were identified and ingestion of raw pork and blood was thought to be the primary risk factor[6]. A case-series of forty-one cases of *S. suis* meningitis in northern Thailand was published in May 2008[7].

The largest human *S. suis* outbreak reported involved 215 cases in Sichuan, China in July to August 2005[8]. This outbreak followed a pig die-off. It was characterized by a high (28%) prevalence of Streptococcus Toxic Shock Syndrome (STSS) and a high (18%) case fatality proportion; the major risk factors were slaughtering a sick pig or handling the carcass of a pig that had died from unknown causes. Almost half (48%) of the cases had wounds on their hands at the time of slaughter or when they had contact with the carcass[8]. Since the occurrence of this outbreak, human *S. suis* cases have been increasingly recognized worldwide.

On 1 May 2007, a health officer at Hospital A in Phayao Province reported five human *S. suis* cases, all from a single sub-district. Each case had presented with acute onset of high fever, severe headache, arthalgia, severe muscle pain and altered consciousness. All were admitted to the intensive care unit. At the time of the report, two patients had died, and two required mechanical ventilation. We investigated in order to verify the diagnosis, confirm the outbreak, describe the epidemiological characteristics of the outbreak, and assist in implementing control measures.

Methods

Phayao is an agricultural province located in northern Thailand. Traditional ingestion of raw pork and blood remains a common practice.

We performed a descriptive study by reviewing all cases of meningitis, encephalitis, and cases of septicemia of unknown origin during the previous three years in Phu Sang District. We interviewed eight laboratory-confirmed hospitalized cases and for one deceased case interviewed family members as proxies. We performed active case finding by reviewing medical records of admitted patients and also sought to identify additional cases within the community. Duration of the study period was two weeks before the first case occurred (12 Apr) to one week after the last case (11 May).

We defined a suspected case as a person who lived in village 4, 5 or 9 of Thung Kluai Sub-district, Phu Sang District, Phayao Province who had fever and at least one of signs or symptoms, including severe myalgia, severe headache, nausea/vomiting, diarrhea, arthalgia, ecchymosis, neck stiffness, seizure or alteration of consciousness between 12 Apr and 11 May 2007. A confirmed case was defined as a suspected case with laboratory detection of *S. suis* by hemoculture or cerebrospinal fluid (CSF) culture with streptococcal colony growth positive for alpha-hemolysis and confirmation with the API 20 Strep test (bioMérieux) or ELISA. Around all case-patient houses, we conducted a survey of domesticated pigs, pig farms, pig slaughtering processes and cooking techniques. We took blood samples from ten of the pigs at Slaughterhouse C. We did a trace back of sources of pork meat served during the funeral day.

We conducted a case-control study to determine risk factors for human *S. suis* infection. The first nine cases (31%) with positive hemocultures of the 29 confirmed cases were included in the study. All nine had attended a funeral ceremony. We defined

controls as people who had attended the funeral ceremony in village 5 on 25 Apr 2007, had no symptoms during the past two weeks, and had no positive laboratory results. From a list of 2,300 residents registered for care in the local health centers, we used simple random sampling to select 76 potential controls from the three villages. Of these, we identified 36 (47%) people who met the definition for control. We calculated crude and adjusted odds ratios (ORs) to quantify associations between disease and exposure.

Results

Figure 1 shows an increase in the number of unspecified etiology meningitis and encephalitis cases in Phu Sang District in April 2007 compared to the same month in previous years. We identified 50 *S. suis* cases (29 laboratory confirmed, 21 suspected cases); the epidemic curve is shown in figure 2.

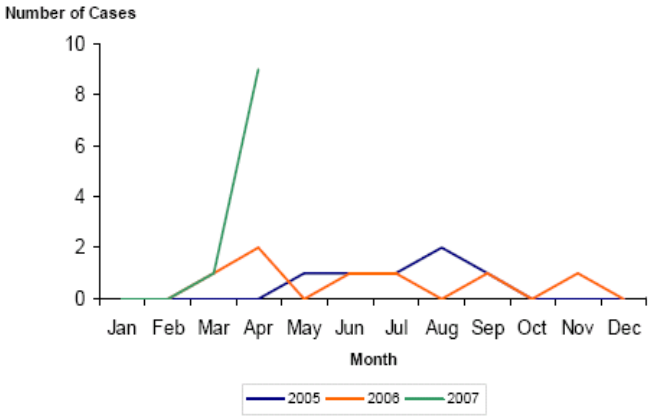
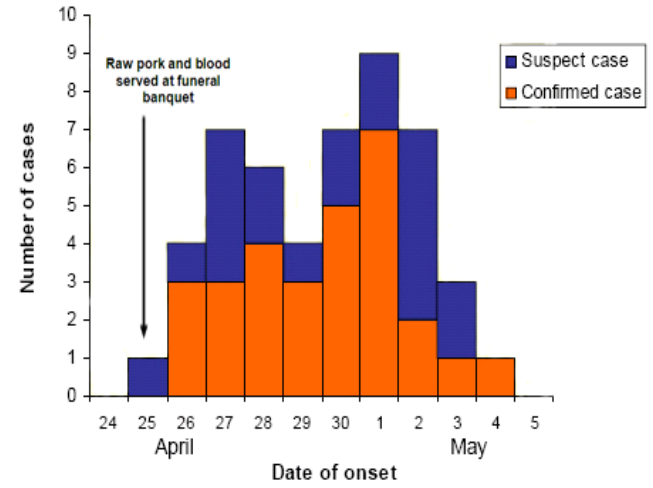


Figure 1. Reported cases of meningitis and encephalitis by month in Phu Sang District, Phayao Province, Thailand, 2005 – 2007



** Date of onset for one case was unavailable*

Figure 2. Cases of *S. Suis* infection (N=49*) in Phu Sang District, Phayao Province, Thailand, April to May 2007

The male-to-female ratio was 1.3:1, and the median age was 49 years old (range 10-77). Of the cases, 48 (96%) were hospitalized, seven in the intensive care unit; one (2%) patient developed STSS, shown in figure 3. Three (6%) patients died. Clinical manifestations are summarized in figure 4; case outcomes are shown in table 1.

Figure 3. Streptococcal Toxic Shock Syndrome (STSS) (a) septic arthritis; (b) ecchymosis

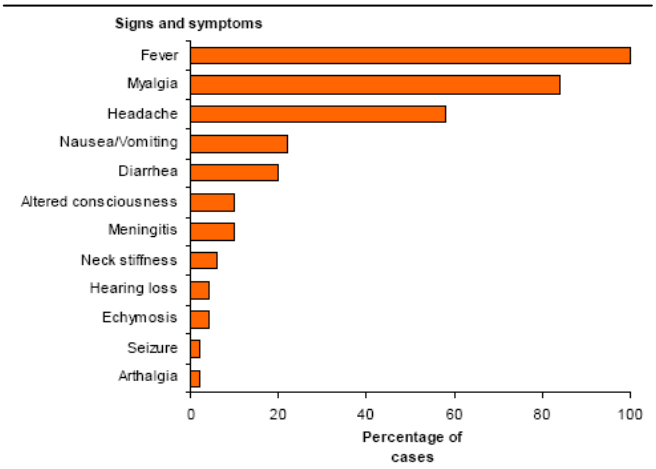


Figure 4. Signs and symptom frequency of *S. Suis* infection in Phu Sang District, Phayao Province, Thailand, April to May 2007 (N=50)

Most cases lived in village 5, in Thung Kluai Sub-district. The index case developed symptoms hours after attending a funeral banquet on 25 Apr 2007 in village 5; the menu for this banquet included fresh pig blood and raw pork. The results from the interviews with the nine patients/proxies are presented in table 2.

Table 1. Outcomes of *S. suis* cases of in Phu Sang District, Phayao Province, Thailand, April to May 2007 (N=50)

Outcome	Number of Cases (%)
Hospitalized	48 (96)
Intensive care unit	7 (14)
STSS*	1 (2)
Death	3 (6)

***** *Streptococcus toxic shock syndrome*

Table 2. Demographic and raw pork/blood consumption data for nine confirmed cases of *S. Suis*, Phu Sang District, Phayao Province, Thailand on 25 Apr 2007

Case	Sex	Age	Ate Meal:		
			Breakfast	Lunch	Dinner
1	Male	56	No	Yes	No
2	Male	50	Yes	Yes	No
3	Male	43	Yes	Yes	No
4	Male	51	No	Yes	No
5	Male	41	Yes	Yes	No
6	Male	49	No	Yes	No
7	Male	50	Yes	Yes	No
8	Male	62	Yes	Yes	No
9	Male	71	No	Yes	No

Raw meat and blood served at the funeral banquet came from three sources: four pigs from farm A, seven pigs from farm B and one pig supplied and

slaughtered by the family of the deceased. Slaughterhouse C provided 10 kg of raw meat and 200 kg of grilled meat to the funeral and others in the sub-district area. We did not find any cases related to other pork provided by slaughterhouse C.

Farms A and B were located outside the village, and no crowding of animals was observed. No sick pigs or piglets were found. These farms supplied pigs to slaughterhouse C. Slaughterhouse C's pig sties were very crowded and a small number of sick-appearing pigs were present (exact number unknown). Serum specimens taken from three of ten pigs housed in slaughterhouse C were positive for Streptococcus species. The pig supplied from the family of the deceased was slaughtered and butchered beside a pigsty; its heart was punctured by a shape knife and blood was collected for a special breakfast dish served the morning of 25 Apr 2007.

We identified 148 people in the community with connections to the cases; 56 (38%) were willing to submit samples for hemoculture. Ten (18%) of these specimens were positive for *S. suis* type 2. Four of 11 CSF cultures were positive. A total of 1,432 people requested *S. suis* screening at local health facilities; laboratory results are shown in figure 5.

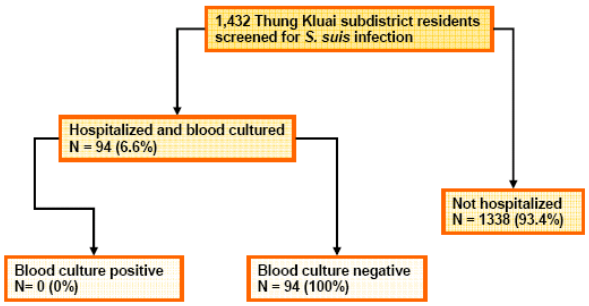


Figure 5. Screening for *S. Suis* infection following outbreak in Phu Sang District, Phayao Province, Thailand, April – May 2007

All nine cases had a history of ingesting raw pig blood or meat on the funeral day. Crude ORs of eating blood, intestines and other internal organs were 48.0, 17.5 and 10.1, respectively (Table 3). In multivariate analysis, the sole factor that remained statistically significant was eating blood, with an adjusted OR of 24.8 (95% confidence interval: 1.46 – 423.53) (Table 4).

Table 3. Univariate analysis of pork-product consumption in *S. suis* outbreak, Phu Sang District, Phayao Province, Thailand on 25 Apr 2007

Type of Pork	Case (N=9)		Control (N=36)		Crude OR	95% CI
	Exposed (N)	Un-exposed (N)	Exposed (N)	Un-exposed (N)		
Any	9	0	35	1	NA	NA
Nose or mouth	0	9	1	34	NA	NA
Neck	1	8	0	35	NA	NA
Pork	9	0	33	2	NA	NA
Blood	8	1	5	30	48.0	4.9-471.3
Intestine	8	1	11	24	17.5	1.9-157.2
Internal organ	7	2	9	26	10.1	1.8-57.9

Table 4. Multivariate analysis of pork-product consumption in *S. suis* outbreak, Phu Sang District, Phayao Province, Thailand on 25 Apr 2007.

Exposure	Crude Odds Ratio	95% Confidence Interval	Adjusted Odds Ratio*	95% Confidence Interval
Blood	48.0	4.9-471.3	24.8	1.5-423.5
Intestine	17.5	1.9-157.2	1.7	0.1-44.8
Internal organ	10.1	1.8-57.9	2.0	0.2-24.5

* *Model included three all three exposure terms*

Discussion

This is the largest *S. suis* outbreak reported in Thailand. This outbreak differs from the 2005 Sichuan, China outbreak in several ways including concomitant porcine disease, risk factors and clinical severity. There was no evidence of a widespread pig die-off in Phayao Province. Our environmental survey of slaughterhouse C indicated that a small number of pigs were ill. Three of ten porcine blood cultures were streptococcus positive, but available evidence cannot confirm that slaughterhouse C was the source of contaminated pork in this outbreak. In the Sichuan outbreak, slaughtering pigs was the strongest risk factor for disease. In this outbreak, consumption of raw pork blood was the principal risk factor. Both the frequency of STSS and the case fatality proportion were lower in this outbreak than in Sichuan.

Our results raise questions about the magnitude of risk associated with raw blood ingestion compared to the risk associated with raw meat or internal organ ingestion. We did not assess dose response patterns of blood ingestion in our analysis.

Laboratories in Thailand do not routinely test for *S. suis* and may misclassify *S. suis* as *S. viridan* species. In a study in Lumphun Province, of 28 blood cultures reported as *S. viridan*, 19 (67.9%) actually were identified as *S. suis*[9]. Increasing the number of laboratories equipped with appropriate diagnostic capacity to test for *S. suis* – already underway in Thailand – is essential for understanding overall burden of disease and detection of outbreaks.

This investigation was limited by the small fraction of cases included in the analytic study, the small scope of the pig health survey and an inability to trace back the contaminated pork products to a specific source. One major challenge faced by health care workers in this outbreak was social panic. Most hospitalized persons were given intravenous antibiotics for one week while awaiting hemoculture results.

Public Health Action and Recommendations

Soon after confirming the outbreak and verifying the etiology, our team joined with local staff to provide public health education about appropriate cooking of pork and sanitary conditions for pig slaughtering. Due to social panic, many persons requested screening for *S. suis* infection. Team members and

local clinical staff provided screening for more than 1,400 people. Provincial Livestock veterinarians conducted a more comprehensive environmental survey and administered antibiotics to domesticated pigs.

Different epizootiological and epidemiological patterns of *S. suis* have been revealed in various outbreak settings. Careful description and analysis of ongoing outbreaks may provide clues as to how to best prevent and control future infections. The degree of risk posed to humans in *S. suis* outbreaks may vary depending upon whether the source of the outbreak is an epizootic with many dying pigs, a single sick pig or asymptomatic pigs colonized by *S. suis*. Gene sequencing of *S. suis* isolates may yield hints about strain-specific virulence that could provide a more complete understanding of the transmission dynamics of *S. suis*. Indiscrimate antibiotic treatment/prophylaxis of pigs in the outbreak area as a means of disease control was an understandable measure given local panic, but at this time there is no evidence that it is effective in decreasing risk of human disease.

In this outbreak, consumption of raw pig blood was identified as a strong risk factor. Changing eating behavior is highly challenging; assessing the baseline risk through behavioral surveillance and also evaluating the effectiveness of health risk communication could better inform long-term disease control programs.

Acknowledgements

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Suggested Citation

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