

# ASSESSING THE SENSITIVITY OF SURVEILLANCE FOR PNEUMONIA IN RURAL THAILAND

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**Abstract.** We conducted a household survey among Sa Kaeo residents to characterize self-reported health-seeking behavior for pneumonia and the proportion of individuals who seek care at a hospital to determine the coverage of a surveillance system. A 2-stage cluster sample was used to select households. A case of pneumonia was defined as a self-reported history of cough and difficulty breathing for at least 2 days or being given a diagnosis of pneumonia by a healthcare provider in the 12-month period beginning February 1, 2002, and ending January 31, 2003. Interviewers administered a structured questionnaire that asked about clinical illness and utilization of healthcare services. Among 1,600 households, 5,658 persons were surveyed, of whom 62 persons met the case definition. Of the 59 persons with complete data, 53 (90%, 95% CI: 79-96) sought medical care and 47 (80%, 95% CI: 67-89) sought care at a hospital facility in the province. Neither distance nor cost was reported as a barrier to seeking care. Most individuals with self-reported pneumonia sought care at the hospital level. Population-based surveillance can provide reliable estimates of hospitalized, chest radiograph-confirmed pneumonia in Sa Kaeo if adjustments are made to account for the proportion of individuals who access a hospital where radiologic assessment is available.

## INTRODUCTION

Pneumonia is one of the leading causes of morbidity and mortality in developing coun-

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tries, particularly among persons less than 5 years of age (WHO, 1999b; Williams *et al*, 2002). The most common bacterial agents causing pneumonia are *Streptococcus pneumoniae* (pneumococcus) and *Haemophilus influenzae* (Shann, 1986; Wall *et al*, 1986; Ghafoor *et al*, 1990; Forgie *et al*, 1991a,b; Adegbola *et al*, 1994). While it is estimated

that pneumococcus and *H. influenzae* contribute to over 1 million deaths annually among young children in developing countries (WHO, 1999a, 2006, 2007), vaccines have been shown to dramatically decrease the incidence of these diseases in both developed and developing countries (Black *et al*, 1991; Lagos *et al*, 1996; CDC, 2000; Whitney *et al*, 2003).

In 2002, an active, population-based surveillance system for hospitalized, chest radiograph-confirmed pneumonia was introduced in Sa Kaeo Province, Thailand, supplementing the pre-existing passive surveillance system for pneumonia (Olsen *et al*, 2006). The goals of this active surveillance system are to obtain accurate estimates of disease burden and determine the primary etiologies of pneumonia in order to guide policy decisions such as new vaccine introduction. Because this surveillance system is hospital-based and the majority of radiograph machines in this province are found in hospitals, the coverage of the surveillance system is contingent upon the proportion of individuals with pneumonia who seek care at the hospital and subsequently receive a chest radiograph.

In 2003, we conducted a household survey to determine what proportion of individuals living in Sa Kaeo Province who had self-reported pneumonia in the previous year sought care at the hospital level to address the sensitivity of our surveillance system to identify possible cases. The second aspect of being captured in the system, receiving a chest radiograph, is addressed elsewhere (Olsen *et al*, 2006). In addition, because health-seeking behavior may be influenced by characteristics such as sex, income, and education (Chen *et al*, 1981; Sen, 1984; Das Gupta, 1987; Ganatra and Hirve, 1994; Srivastava and Nayak, 1995; Konradsen *et al*, 1997; Okanurak *et al*, 1997; Goldman *et al*, 2002; D'Souza, 2003; Pillai *et al*, 2003), we also examined the presence of any association among these characteristics and self-reported

illness and seeking care. The results from this survey will ultimately be used to adjust data on the incidence of hospitalized, chest radiograph-confirmed pneumonia from the surveillance system to generate accurate estimates of the burden of pneumonia in Sa Kaeo, Thailand.

## MATERIALS AND METHODS

Sa Kaeo is a rural, agrarian province located in the eastern part of Thailand, bordering on Cambodia. In 2001, the total population of the province was 438,557 persons, served by 8 hospitals. In 2002, the provincial health office estimated the number of registered and unregistered migrant workers to be approximately 25,000. As of the 1999 census, there were 610 villages throughout the province, the number of households within each village ranging from 15 to 2,978. The average monthly household income is 6,958 baht or US\$ 155 (Anonymous, 2001). Health-care services are sought from a variety of persons and places, including village health volunteers, pharmacists, drug sellers (people who sell medications in stores not designated as pharmacies), health centers, private physician offices, and hospital facilities including outpatient departments, emergency departments, and inpatient departments.

A 2-stage cluster sample was used to select households for the survey. The necessary sample size was calculated using the 2002 incidence of pneumonia from the passive surveillance system (1.9 cases per 1,000 persons) and a 95% confidence interval around this estimate. This sample size was inflated to account for an estimated non-response rate of 20% based on previous household surveys with response rates of 82% and 94% (Winston and Patel, 1995; Ng *et al*, 2002). This sample size was further inflated by a factor of 1.5 as the estimated design effect to account for the clustering of pneumonia cases by

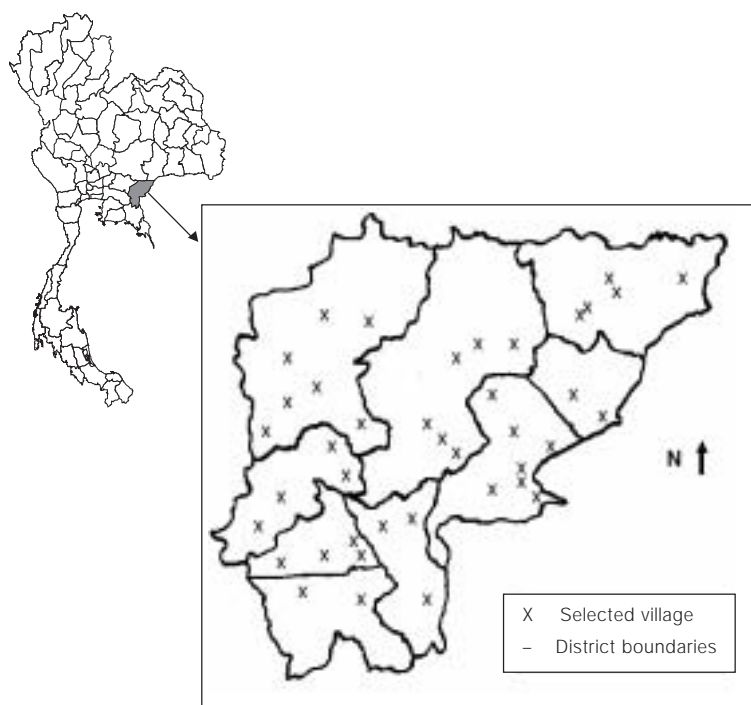


Fig 1—Villages selected for inclusion into a household survey examining health-seeking patterns for pneumonia, Sa Kaeo Province, Thailand, June 2003.

village and by household. The final sample size was 1,600 households. Using probability proportional to size, 40 villages were randomly selected from the total of 610 villages in Sa Kaeo Province in the first stage based on the number of households in each village (Fig 1). In the second stage, a sample of 40 households was selected within each village. The start household for each village sample was identified by randomly selecting 1 house number from a list of all house numbers for that village. Subsequent households were selected as the interviewers walked to the next nearest household following a series of standardized instructions given to each team of interviewers.

A household member was defined as any individual who had slept in a given household

for at least 6 of the preceding 12 months, including persons who were deceased at the time of the interview. The caretaker for a household was the person responsible for the health of members in the household and/or a person who takes care of the children for more than 2 hours a day. A “no response” household was defined as one in which there was no answer on 3 separate visits at least 24 hours apart. A case of pneumonia was defined as a self-reported history of a cough and difficulty breathing for at least 2 days or being given a diagnosis of pneumonia by a healthcare provider in the 12-month period beginning February 1, 2002, and ending January 31, 2003, in an individual living in Sa Kaeo Province. This case definition of pneumonia was adapted from

the World Health Organization (WHO) verbal autopsy report for severe pneumonia in children, using questions that were moderately sensitive and specific for pneumonia (WHO, 1999c).

A 2-part questionnaire was used to collect information from individuals within each household. The first part included demographic information about the household for all the individuals living in that household. Two screening questions were asked of each individual in the household to identify persons who had pneumonia using the case definition described above. The second part was a detailed clinical questionnaire for each individual who met the case definition for pneumonia. Prior to the beginning of the survey, the questionnaire was pilot-tested in Thai, revised in

English, and translated back into Thai for use in the actual interviews.

Ten Sa Kaeo provincial health officers were trained during a 3-day session to ensure standard interview techniques. Interview teams were made up of 2 health officers and a village health volunteer who visited households in the villages to which they were assigned. Visits were made during the day, in the evenings, and on weekends to optimize response rates. The primary caretaker served as a proxy for individuals less than 7 years of age or for any person of any age who was not home; verbal informed assent was obtained for those aged 7 to 19 years (individuals less than 20 are considered minors in Thailand) after permission from the caretaker was obtained verbally. Approval from both the CDC Institutional Review Board and the Thailand Ministry of Public Health Ethical Review Committee was obtained prior to beginning the survey.

Variables were dichotomized as follows: (1) age less than 18 years or age 18 years or more; (2) monthly household income 5,000 baht or less (US\$ 125) or more than 5,000 baht; and (3) caretaker education less than secondary school or at least secondary school. A case household was defined as a household with at least 1 case-patient. Very severe pneumonia in a child less than 3 years of age was defined using the Integrated Management of Childhood Illnesses guidelines (WHO, 2000), – cough or difficulty breathing plus at least 1 of the following: central cyanosis, poor feeding, seizures, unconsciousness, or decreased activity. Severe illness in a person 3 years of age or more was defined as difficulty breathing, fast breathing, and confusion during the illness.

SAS 8.2 (SAS Institute, Cary, NC) was used to perform descriptive analysis. We report frequencies with Fleiss quadratic 95% confidence intervals. Because a self-weight-

ing design was used in the first stage of sampling (probability proportional to size at the village level) and each individual in the household was interviewed, each observation (household or individual) had an equal weight of 1 in all analyses. When possible, comparisons between groups were made using SAS-Callable SUDAAN (SUDAAN Version 8.0, RTI International, Research Triangle Park, NC) to account for clustering at the village and household level. The significance of association for each variable was determined using the Wald chi-square test. Crude odds ratios (cORs) and 95% confidence intervals (CIs) were calculated; Fisher's exact test was used to determine significance when expected cell size was less than 5.

## RESULTS

During the time period beginning May 28, 2003 and ending June 20, 2003, we visited 1,600 households, of which 1,598 (99.9%) had a caretaker who agreed to participate. One household was deemed a "no response" household and the caretaker of the other household declined to participate. A total study population of 5,658 persons was interviewed, giving a median 3 persons per household with a range of 1 to 12 persons per household. Half of the study population was male and age ranged from less than 1 year to 108 years (Table 1). Seventy-one percent (1,131/1,597) of households had a monthly income of 5,000 baht or less (US\$ 125); 86% (1,382/1,598) had a primary caretaker with less than a secondary school education; 94% (1,507/1,598) had a television, radio, or telephone; and 48% (772/1,598) of households had a primary source of income from farming/agriculture.

Of the 5,658 persons interviewed, 62 (1%, 95% CI: 0.8-1.4) met the pneumonia case definition, yielding a rate of 11 cases per 1,000 persons (95% CI: 8.6-14.1 cases per

Table 1  
Demographic characteristics of the study population ( $N=5,658$ ) and case-patients ( $n=62$ ) in a household survey examining health-seeking patterns for pneumonia, Sa Kaeo Province, Thailand, June 2003.

Characteristic	Total population (%)	Case-patients (%)
Age group (yrs)		
<3	216 (3.8)	12 (19.4)
3-17	1,655 (29.3)	26 (41.9)
18-64	3,291 (58.2)	16 (25.8)
$\geq 65$	448 (7.9)	8 (12.9)
Missing	48 (0.8)	-
Less than five years of age	408 (7.2)	21 (33.9)
Male	2,800 (49.5)	41 (66.1)
Female	2,854 (50.4)	21 (33.9)
Missing	4 (-)	-

1,000 persons). The cases were distributed among 26 of the 40 selected villages and there were 3 households with 2 cases each. The majority [60/62 (96.8%)] met the case definition by having cough and difficulty breathing for at least 2 days alone or in combination with being given a diagnosis of pneumonia by a health-care provider; 2 case-patients met the case definition by being given a diagnosis of pneumonia only. Three case-patients did not have the more detailed questionnaire administered. In the remainder of the results, we describe the 59 cases for which we have complete information. Nine individuals answered the detailed questionnaire themselves; the caretaker served as a proxy for the remaining 50 case-patients.

Case-patients had duration of illness ranging from 1 to 40 days with a median of 7 days. Eleven (92%, 95% CI: 60-100) of the 12 children less than 3 years of age met the IMCI criteria for very severe pneumonia and 12 (26%, 95% CI: 14-41) of the 47 individuals

three years of age or older met the criteria for severe illness. Fifty-four (92%, 95% CI: 81-97) sought care for their illness, but 1 of these individuals sought care outside of Sa Kaeo Province, leaving 53 (90%, 95% CI: 79-96) of the 59 patients having sought care in Sa Kaeo Province. The following were reasons (not mutually exclusive) why the 5 individuals did not seek care: (1) not sick enough ( $n=3$ ); (2) thought getting better ( $n=2$ ); (3) thought would get a serious disease ( $n=1$ ); or (4) afraid of receiving an injection ( $n=1$ ). All 5 of these individuals were males and all but one, who was 9 years old, was over 50 years of age.

Of the 59 case-patients, 47 (80%, 95% CI: 67-89) sought care at the level of a hospital (outpatient, emergency, or inpatient department) within the province. Individuals who were younger appeared to be more likely to go to a hospital when seeking care than individuals who were older: 0-14 years of age [32/37 (86%, 95% CI: 70-95)], 15-64 years of age [10/14 (71%, 95% CI: 42-90)], and 65 years and older [5/8 (63%, 95% CI: 26-90)]. Nineteen individuals received a chest radiograph and 11 were hospitalized; 8 of these individuals received both. The rate of hospitalized pneumonia in this study population was 2 cases per 1,000 persons. Almost all individuals [56/59 (95%, 95% CI: 85-99)] reported having taken some medication for the illness, 45 (80%, 95% CI: 67-89) of whom stated it was an antibiotic but could not provide the name.

The most frequently visited sites for medical care were the outpatient departments, private physician clinics, and health centers; this pattern was similar to that for where care was sought first (Table 2). Overall, 72% (38/53, 95% CI: 57-83) of case-patients who sought care visited 2 or more places, although all case-patients who first sought care at a health center subsequently sought care elsewhere. Among the 11 case-patients who were admitted to the hospital, 8 (73%, 95% CI: 39-93)

Table 2  
Pattern of health-seeking among case-patients who sought care ( $n=53$ ) in a household survey examining health-seeking patterns for pneumonia, Sa Kaeo Province, Thailand, June 2003.

Location	No. (%) <sup>a</sup>	No. who went there first (%)
Outpatient department <sup>b</sup>	36 (67.9)	19 (35.8)
Private physician clinic	29 (54.7)	14 (26.4)
Health center	18 (34.0)	12 (22.6)
Inpatient department <sup>b</sup>	11 (20.8)	1 (1.9)
Drug seller	4 (7.5)	3 (5.7)
Emergency department <sup>b</sup>	2 (3.8)	2 (3.8)
Pharmacy	1 (1.9)	1 (1.9)
Health volunteer	1 (1.9)	1 (1.9)

<sup>a</sup>Sum is greater than 53 because some case-patients sought care from more than one place

<sup>b</sup>Considered a hospital facility

sought care at a private physician's office immediately prior to being admitted to the hospital. For 1 person, the hospital inpatient department was the first and only place he sought care. The other 2 individuals sought care at an outpatient department or from a drug seller prior to hospital admission.

The survey and the surveillance system overlapped for 5 months (September 2002 - January 2003). During this time, 5 of the 11 case-patients reportedly were admitted to a hospital in Sa Kaeo. To try and assess validity, data (name, age, sex, month of onset) on 4 of 5 patients were known and could be compared to surveillance records. Only one was considered a match. However, nicknames were reported on the survey forms instead of full names, making the comparisons difficult.

In this study, 12 (20%, 95% CI: 11-33) of the 59 case-patients did not seek care at the level of a hospital within the province. If we assume that the 12 individuals who did not seek care truly had pneumonia, then the esti-

mates calculated from the active surveillance system may be underestimating the true incidence of pneumonia by as much as 20%.

## DISCUSSION

Our study found that the majority of individuals with self-reported pneumonia sought care at the level of the hospital at some point during the course of their illness. Because one of the required criteria of this hospital-based surveillance system is reaching the hospital where an individual has the opportunity to have a chest radiograph and/or be admitted to the hospital, our study findings suggest that most pneumonia cases could be captured by this active, population-based surveillance system, provided chest radiographs are readily available and utilized. Further examination of who gets a chest radiograph among individuals with possible pneumonia is addressed elsewhere (Olsen *et al*, 2006).

Travel time and cost were originally hypothesized as potential barriers to care given the rural nature of the province and the low average household income. However, this was not the case based on self-reported information from this study. Instead, self-assessments that the illness was not severe enough or was improving and fear of going to the doctor were reasons for not seeking healthcare services.

The extended period of illness recall, up to 18 months prior to the interview, may have led to selective reporting of more severe illnesses. Although shorter recall times are associated with more accurate reporting of information, the seasonal nature and low reported baseline incidence of pneumonia prevented us from shortening the recall time. In addition, the use of self-reporting and proxies during the interviews could have introduced additional biases.

Misclassification was also a concern, as the case definition was moderately sensitive and specific. Given that our rate of hospitalized pneu-



monia was equivalent to that found in the passive surveillance system (Kanlayanaphotporn *et al*, 2004), we surmise that our definition was only moderately sensitive. However, with different case definitions it is difficult to directly compare the two rates. On the other hand, it is possible that self-reported cases of pneumonia in our study may not actually have been pneumonia but a more mild acute respiratory infection given the moderate level of specificity in the case definition. However, since we were most concerned about people's ability to travel to the hospital and our study group potentially included individuals with more mild illness, we can presume that people will be just as likely, if not more, to seek care when more severely ill with pneumonia. A secondary problem with our case definition was that we used the same case definition for adults given the lack of a consistent case definition for pneumonia for adults.

Thailand is a middle-income country with good access to health care. In countries where similar surveillance systems are being established, this approach to evaluating the coverage of the system should be considered, as hospital accessibility will vary between and within countries.

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